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QUARTERLY

OF THE

National Fire Protection Association

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National Fire Protection Association.

(INTERNATIONAL.)

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Western Actuarial Bureau (Fire).
Western Canada Fire Underwriters' Association.
Western Factory Insurance Association.
Western Insurance Bureau.
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Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

Courtesy of Frank Stanbery, Nebraska Inspection Bureau, Member N. F. P. A.

The fire at the Armour & Company packing plant at Omaha, Nebraska, February 14, 1923. Sprinklers could not hold the fire and a very large property damage resulted. **(See also page 358.)**

WHO WANTS TO ANSWER THIS?

Why do you suppose it is that the city of London, England, has about fifteen hundred men in its fire department, and the city of New York, about the same size, has four thousand?—*Richard E. Vernor.*

The Quarterly

Vol. 16 **April, 1923** **No. 4**

Twenty-Seventh Annual Meeting. It is three years since our last annual meeting in Chicago. Our convention in 1920 was held in the auditorium of the Insurance Exchange, an ideal room for a meeting of the nature of ours, but which with our growth and development is no longer large enough for our purpose. This year, therefore, May 8, 9, 10, we are to assemble in one of Chicago's beautiful new hotels, The Drake, the location of which, on the lake shore of the "North Side," away from the noise and confusion of the "Loop" district, is admirable. The three years past have added much to the beauty of Chicago, especially to the impressiveness of the majestic boulevard, Michigan Avenue, which is now extended over the river to the north. The Drake is but a few blocks from Underwriters' Laboratories farther out along the shore of Lake Michigan. The assembly room is on the main floor and opens upon a terrace. The equipment, accommodations and service are of the best. The official program to be mailed to members shortly and the announcements in the *News Letter* will indicate the budget of committee reports to be presented, and other items of the meeting.

* * * * *

Canadian Church Fires. The number of fires in churches in Canada has been so great during the past winter months as to bewilder the church-goers of the Dominion and to cause the apprehension that a conspiracy existed to destroy church property of all denominations. No evidence, however, seems to have been brought forward to prove that these frequent fires were of incendiary origin; in fact most of them are believed by the Chairman of our Canadian Committee, George H. Greenfield, to have been due to defective heating systems or bad housekeeping, and he has recently requested the members of his committee to urge church trustees throughout the Dominion to give attention to the common heating and lighting hazards of these edifices.

There existed in New England during the last century a notion that it was impious to install a lightning rod on a church because such a precaution indicated lack of faith in the loving care of the Deity. Modern so-called higher criticism, operating as a cloak for common sense, has largely dissipated perhaps such notions among intelligent people. It is now generally recognized that natural laws are inexorable, still, the lack

(See also page 306.)

the fire and a very large property damage resulted.

of care commonly exercised over fire hazards of churches creates a condition as disaster-inviting as if the old mischievous ideas still prevailed. The further fact that many churches are not insured in the manner of ordinary business properties results in their going frequently for long periods without competent inspection. Heaters thus become defective, lighting apparatus sub-standard, and housekeeping conditions bad; and these conditions continue until a period of extreme cold or the use of substitute fuels places too great a tax upon things as they are. It is doubtful if any of the Canadian church fires this past winter were incendiary, except that carelessness or neglect is an incendiary.

* * * * *

Electricity Takes Fifth Place as Fire Cause.

From the time of its first introduction electricity has been recognized as a fire cause of major importance. Electricity's capacity for starting fire was demonstrated promptly, and rules to control its hazard were first promulgated in 1881. These early rules were later amalgamated into the National Electrical Code, which has now become the National Fire Protection Association's best known standard.

In spite of progressive improvements in electric equipment and methods of installation the annual losses due to fires of electrical origin continued heavy. The use of electricity was growing faster than precautions to safeguard it could be developed. No complete loss analysis figures are available prior to 1915, but it is safe to assume that the average fire loss due to electricity since 1915, reported by the Actuarial Bureau of the National Board of Fire Underwriters, is a fair criterion for a number of years earlier.

According to the Actuarial Bureau's figures (which the Bureau states should be increased 25 per cent to cover unreported losses) for 1915-19, the loss due to fires of electrical origin was $84,086,471, an average of nearly seventeen million dollars a year. This was the largest item among the classified fire losses due to known causes, and amounted to 15 per cent of the total, excluding those of unknown origin or those due to exposure and conflagration.

In 1920 "matches—smoking" displaced electricity as the most important fire cause, and in 1921, as shown by the statistics published on another page of this issue of the QUARTERLY, electricity has taken fifth place, with a total loss of $12,723,000. This is a decrease of four million dollars from the 1915-19 average, and is eight per cent of the total loss as compared with the 15 per cent for the 1915-19 referred to above. While the influence of a few large fires on statistics of this kind may modify the results for a single year by several million dollars the change is nevertheless so striking that it should not pass without comment. The reduction in loss due to fires of electrical origin is remarkable in view of the tremendous increase in the use of electricity. It may be due to a number of factors, to the gradual replacement of old substandard wiring by new installations conforming to the latest requirements of the National Electrical Code, to better inspection service, to progress in the education of users of electricity as to its fire hazards, and to increased co-operation in promoting safety in the use of electricity on the part of the electrical industry. Whatever may be the relative influence of these several factors, the result gives encouraging evidence of the value of fire prevention efforts in this field.

The Inflammable Picture Film in Boston. Rare good luck attended a fire from a nitro-cellulose motion picture film in the building of the Oliver Ditson Co., music publishers, of Boston, recently. In the offices of some advertising agents on the ninth floor the *New York Tribune* was displaying two films to the executives of the company, using two portable projectors over which was set a small steel and asbestos box in lieu of the required safety booth. The first film to be run caught fire and the operator attempted to tear it, knocking the reel on to the floor where it was consumed. The operator was an experienced man and the executives viewing the picture were not stampeded. The film fire was cooled slightly by the contents of two soda-acid extinguishers and the damage to the building was the smoking up of the furnishings and decorations. This damage the *New York Tribune* made good, explaining at the same time that the inflammable nature of the film was not known, slow-burning film having been ordered.

The culpability of this newspaper in neglecting to ascertain the character of the film it was using and in violating the laws of Massachusetts in the Ditson building display cannot be disputed. The incident is eloquent of the long series of "didn't know it was loaded" stories that will be offered to the public as soon as the movie theatre discarded gun-cotton film now being sold to amateurs throughout the country begins to register its reprisals in fires and death.

* * * * *

Office Building Floor Loads. The floor loads prescribed for building design vary picturesquely in the building code requirements of different cities, indicating a lack of definite information as to actual loading conditions found in practice. Thus one of the important problems confronting the Building Code Committee of the U. S. Department of Commerce, of which Ira H. Woolson (chairman N. F. P. A. Committee on Building Construction) is chairman, is that of determining the actual conditions of floor load which may be expected in practice, and on which reasonable design requirements of building codes may be based. As a start in compiling the requisite data, the committee has secured figures on typical office floor loads in the Equitable Building, New York, and in the Union Central Life Insurance Co. Building in Cincinnati, and has collected the results of the few previously published investigations on this subject. This data is presented in an article published in the *Engineering News Record* (March 29, 1923, p. 584), in the *American Architect and Architectural Review* (March 28, 1923), and in the *Architectural Forum, Buildings and Building Management, Concrete, Distribution and Warehousing,* and the *American Machinist.*

The most interesting part of this article describes the typical office floor loadings in the Equitable Building, where loads were determined by weighing each article of furniture in the office under consideration, and making an estimated allowance for the weight of the occupants. In this building the average live load per square foot was found to be 11.6 pounds, with individual offices varying from 1 lb. to 78 lbs. per square foot, the latter figure representing the loads in the file room of a bonding company, and the stack room of a law library.

This investigation is of great interest primarily because it seems to indicate that considerable economies may be effected without endangering the safety of building construction by lightening the design of columns which are now customarily figured for comparatively heavy average floor loads, and incidentally because of the relation of floor loads to structural damage to buildings in case of fire. It is to be hoped that the Building Code Committee will succeed in securing without delay necessary additional data on actual floor loading conditions not only in office buildings but in structures of every class, so that they may be enabled to make much needed recommendations as to minimum requirements for safe and economical building design.

* * * * *

The Silent Watchman. A discriminating and instructive editorial on a point in fire protection is not yet so common in the columns of American newspapers as to permit us to pass without special attention the following, appearing in a recent issue of the *Boston Herald:*

Nipped in the Kindling.

In the basement of a large apartment house on Beacon Street, a night or two ago, a mysterious fire began to climb the inner sides of a three-decked wooden closet. The contents were mainly screens, standing on edge as if the better to burn. The closet was one of a row, each was packed with screens and with the riff-raff that accumulates under a thrifty janitor's care. Within arm's reach was a long bench, used for carpentry and painting; it was oily. Well dried combustibles were all about; here, a stack of odd pieces of lumber; there, broken chairs; against a wall, the remains of a discontinued flight of stairs. This part of the basement, large in itself, opened into a narrow hallway leading past a series of lightly partitioned store rooms into the bottom of the stairway, that rose, story by story, around the service elevator shaft. Upstairs in the quiet apartments the tenants were fast asleep. And so the little fire, now catching in a box of excelsior, had its work laid out for it, like the train of powder that leads to a charge.

—What happened?

By the time that the flames had reached the excelsior, and bitten well into the back of the closet door, and edged upward past the decks, they had generated heat enough to fuse the metal on two automatic sprinkler heads, just below the ceiling. Instantly the combined sprays drenched down the closet. That blackened fire had never had a chance. And yet, do you remember how owners protested when the aroused public insisted that our five-story apartment houses, built of wood walled in with brick, should be made safer for all concerned?

Such a forceful and cleverly written presentation of a specific case of property and probably life saving by a newspaper in a city that has not been free from apartment house fire horrors is of singular educative value.

* * * * *

The Lions' Share. The application of the San Francisco "Den" of the International Association of Lions' Clubs for associate membership in the N. F. P. A. indicates that the activity of this excellent organization in fire prevention work is to be more than sporadic. The Lions, the Kiwanis and the Rotary clubs have always offered cordially their speaking platforms for fire prevention talks but the Lions' Clubs seem to be preparing to do something on their own. The fire prevention movement among the locals of this organization has been

extended throughout California. Since taking up this matter last October one hundred meetings have been held by the organization in that state, and the joint meeting with the San Francisco Commercial Club on April 18, the anniversary of the big fire, indicates that the metropolis is not left out of the field of the Lions' Clubs' fire prevention activities. The California clubs have decided to bring the subject before the convention of the International body at Atlantic City in May with the object of making fire prevention activities a permanent plank in the platform of the organization. If success attends this effort the Lions' will have taken a step notably in advance of any taken by its sister organizations in thus adopting a welfare work whose interest and significance is national as well as local.

* * * * *

More Unconscious Incendiarism.

The *Boston Daily Globe* in its commendable efforts to smooth the rocky road of life for its constant readers occasionally plays the role of Happy Hooligan. In its issue of March 31 it prints this with a drawing of a lighted candle inside a paper bag:

> There are times, even in these electrically and gas lighted days, when candles must occasionally be burned for illumination. But to carry a lighted candle out to the garage or down cellar or in places where winds and drafts exist is somewhat of a task. Here's a simple way to do it.
>
> Wrap the neck of a large paper bag about the shank of a long candle and then hold the two in the hand as shown. Just the slightest hole can be torn out of the top of the bag to admit fresh air, but not large enough to let the wind in. A candle thus lighted and held will burn for a long time without going out, and if the bag is of light colored or white paper will shed a good light in an emergency.

This brilliant bit of helpfulness has the caption "Economy Kinks" and suggests a syndicated filler which possibly appeared in other papers. Undoubtedly such a contrivance has all the merit the author claims for it. It will shed a good light in an emergency; in fact, it may light up the whole town.

Meeting of Executive Committee.

The midwinter meeting of the executives was held in Atlantic City on January 27, 1922. The following members were present:

Albert T. Bell, Atlantic City, Chairman
J. I. Banash, Chicago
W. F. Ballinger, Philadelphia
Geo. W. Booth, New York
Geo. H. Greenfield, Montreal
H. L. Miner, Wilmington, Del.
F. B. Quackenboss, Nashville
A. M. Schoen, Atlanta
H. V. Thayer, Boston
Louis Wiederhold, Jr., Philadelphia
H. O. Lacount, Boston, President
Rudolph P. Miller, New York, Vice-President
Dana Pierce, New York, Vice-President
F. J. T. Stewart, New York, Past-President
Franklin H. Wentworth, Boston, Secretary.

Business Transacted.

The program of the coming annual meeting of the Association was discussed at request of the Program Committee.

The following Committee on Electric Railway Car Houses and Cars was appointed to prepare and assemble regulations for the safeguarding of such properties: A. M. Schoen, Chairman, N. G. Burgster, J. C. Forsyth, Martin Schreiber.

The matter of the objections of member A. F. Jenkins to Executive Committee action of June 29, 1922, respecting Mr. Jenkins' statement at annual meeting May, 1922, regarding Rule 25 f of Proposed regulations for the installation and operation of Acetylene Compressing Plants was presented and no action taken.

The chairman of the Electrical Committee outlined the present status of the proposed Combined Electrical Fire and Safety Code of the American Engineering Standards Committee.

It was voted to instruct the Electrical Committee acting for the Association to organize a Sectional Committee of the American Engineering Standards Committee to act upon the proposed 1923 revised National Electrical Code, the Electrical Committee to report the findings of the Sectional Committee to the N. F. P. A. as sponsor for the Code under the A. E. S. C.

Action respecting the submission for registration by the American Engineering Standards Committee of the N. F. P. A. regulations govern-

ing First Aid Fire Appliances and Dust Explosion Hazards was deferred.

The International Brotherhood of Electrical Workers was elected a member.

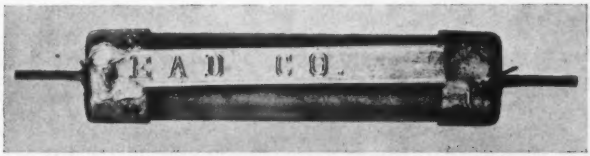
The Committee on Hydrants and Valves was requested to prepare regulations governing Fire Department connections to automatic sprinkler equipments.

The matter of more comprehensive regulations governing local valve alarms in connection with automatic sprinkler equipments was referred to the Committee on Signaling Systems in conference with the Committee on Automatic Sprinklers with the request that this item be adequately covered in the regulations of both committees.

The matter of the proposed tests to determine the adequacy of the present regulations governing pipe sizes and spacing of sprinkler heads was discussed and it was voted to invite the Chairman of the Committee on Automatic Sprinklers and the Chairman of the Special sub-committee having this matter in hand to attend the next meeting of the Executive Committee and discuss the subject with the Executives.

Certain changes in existing committee rosters were made at request of members and the chairmen of committees.

A vote of thanks was tendered to the management of Chalfonte-Haddon Hall for its generous hospitality and unusual courtesies extended to the Committee.



Inspectors are continually reporting finding bridged or "jumpered" fuses in industrial plants and mercantile establishments. The use of pennies is quite common for this purpose and some inspectors claim that they have derived quite a little income by the removal of these hazards. The use of a bar of solder for bridging a fuse is perhaps not quite so common but it certainly is fully as effective in creating a fire hazard. The fuse, shown above, was found in service by Inspector I. E. Peak (Member N. F. P. A.) of the Underwriters Bureau of New England. Mr. Peak very properly appropriated the fuse and courteously loaned it to us for reproduction. As the fuse was a large one and nearly half a bar of solder was used, his find was easily worth several of the common penny variety.

Factors Affecting the Fire Tax Rate.

By Charles E. Worthington.
(Member N. F. P. A.)

When we analyze critically what has been already achieved in reducing the rate of the fire tax we will not be able to permit ourselves to entertain illusions as regards the results of our altruistic efforts. No doubt these have had their effect, but in general other considerations have overshadowed fire prevention and made it an incidental rather than a primary reason for improvements in building construction.

The "built to burn" era of the latter part of the nineteenth century was the outcome of new and undigested economic conditions; industrial expansion viewed through the glass of enthusiasm was seen as a glorious picture of activity and prosperity. A desire was awakened to seize fortune in her flight and think of the consequences afterward. "Facilis decensus Averni," a headlong plunge and a long way out, for that may be done in a decade which will require centuries for its undoing.

It is not surprising that the lure of new and unheard of profit stimulated a universal desire to manufacture and sell something. Time was precious and any available building, however flimsy or unsuitable, was utilized to carry machinery. The lesson of the relation of manufacturing waste to ultimate and continued profit had yet to be learned. Europe already knew it but we of America were not ready to consider European methods and teaching.

Slowly, however, economic conditions changed and the change brought with it a realization of the earlier fallacies. Manufacturing waste and fire waste assumed appalling proportions and began to receive attention as production gradually increased and met foreign competition. With the growth of cities, the centralization of industries and resultant concentration of values and the consequences of the fire waste became more evident. Economic conditions changed rapidly and the need for better protection became apparent. Fire was recognized as an important part of the waste which all modern effort is striving to eliminate.

Structures already in existence could to some extent be bettered but in the main conditions could only be improved through the removal of existing buildings by time and fire. This process is necessarily slow, its results can be measured only after long periods of years, and infinite persistence and patience are necessary to eventual achievement.

Very much of the prospect of decreased fire loss depends on the average character of structural replacements—replacing the old with something safer and better. This is exactly what we have been to a

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EDITOR'S NOTE: This is a continuation of Mr. Worthington's discussion of the economics of the fire waste. See "Are We Winning or Losing?" July 1922 QUARTERLY (Vol. 16, No. 1, p. 49), and "The Decreasing Fire Tax Rate," January 1923 QUARTERLY (Vol. 16, No. 3, p. 230).

certain extent doing, and, in general, doing well—not that we do not still build to burn but we do not do so to anything like the former extent. Much also depends on the use of mechanical devices for fire detection and repression, the improvement of public fire extinguishing facilities and upon conscious and persistent effort to seek out and remove the causes of fire. These statements apply particularly to the great commercial and manufacturing centers, for it is here that we find concentrated values and here only are possible the major conflagrations destroying thousands of buildings in a single sweep. Fear centers in the possibility of territorially great urban fires.

We have made astonishing progress in fire resistive construction ("fireproof" is seemingly impossible) but even yet an isolated fire resistive or sprinklered structure is not a completely reliable conflagration barrier. Grouped, their resistive qualities are increased and it would require a very vivid imagination to picture a sweeping fire in a city entirely of fire resistive construction or even in one completely sprinklered, assuming good water service and pressure and an efficient fire department.

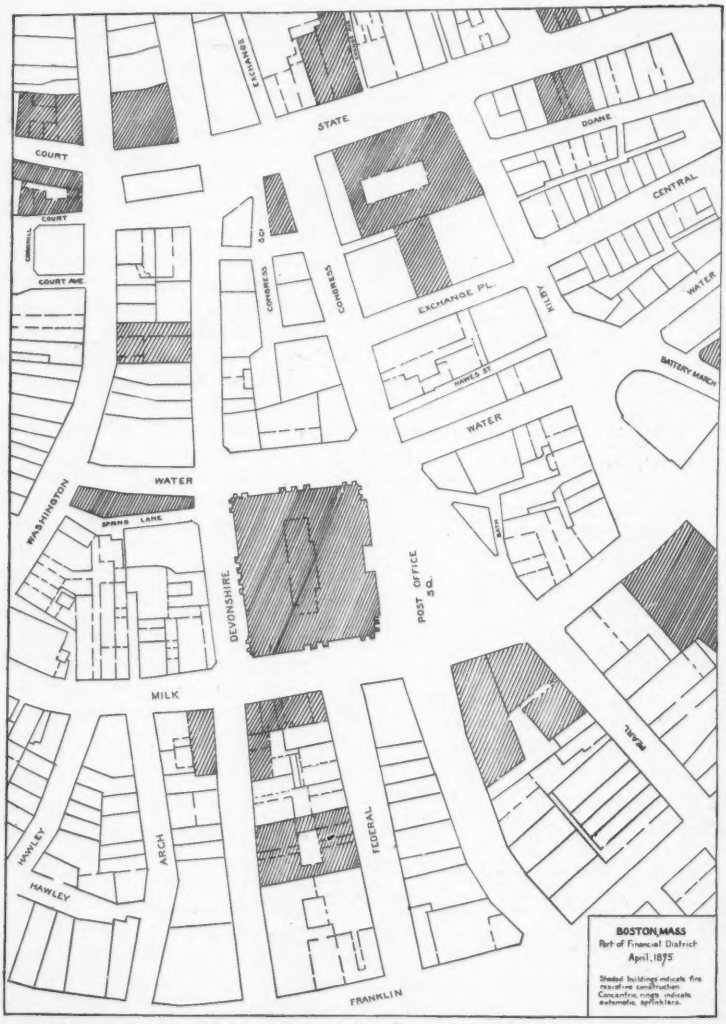
Knowing that the rate of the fire tax has fallen, and that it has fallen not by chance but through the operation of definite causes, it is of interest to discover to what extent the replacement of combustible by fire resistive construction and the extension of automatic sprinkler protection have progressed in our larger cities. To collate statistics of this kind in understandable form would be a practical impossibility for there is no standardization among the various cities either in methods of bookkeeping or in nomenclature, and even if there were it would be hard to arouse sufficient interest on the part of the public officials concerned, relative to matters outside of their regular duties to procure any extensive results. This was, however, attempted by the author. The attempt was met in part by co-operation, courtesy and an attitude of helpfulness highly appreciated, but not to a sufficient extent numerically to make the project feasible.

It seems entirely proper, however, to select a single city as probably typical of the average, selecting for that purpose a conservative city of not over-rapid growth, for which complete details are available. For this purpose Boston seems to be the best choice, since it has a reputation for conservatism that should make it a fair example, which should not differ from the average to any great extent. Maps of Boston at two separate dates are available and the complete system of bookkeeping of the Building Department permits acquisition of the necessary statistics.

For this purpose the building permit records were taken for the first five months of 1914 (the last "normal" year) and corresponding records for 1922.* In 1914 (five months, January to May inclusive) permits were issued for the construction of fourteen first class (fire resistive) buildings and 163 second class (ordinary brick or stone) buildings, and demolition permits were issued to the number of 128. These records are for the entire city but the construction of first class buildings is always chiefly in business districts and of second class very largely so.

In 1922 in the corresponding five months permits for first class construction numbered 235 and for second class 270; demolitions, mainly to

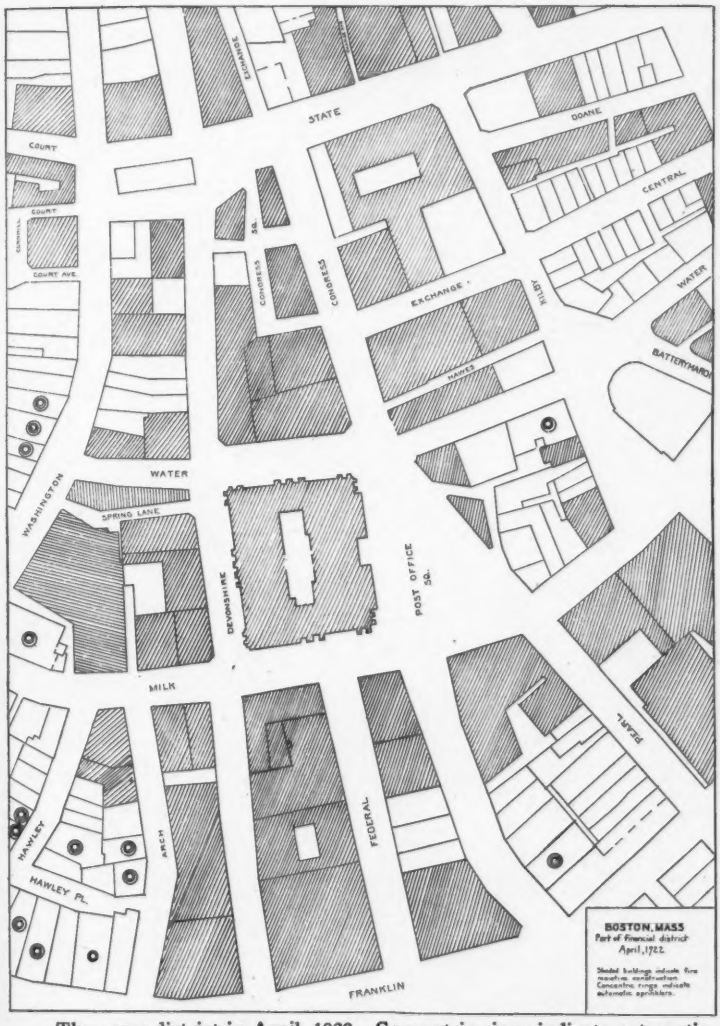
* As data from these records was difficult to extract, it was not attempted to obtain figures for a full year.



Part of Boston's financial district in April, 1895. The shaded buildings indicate fire-resistive construction. There were no buildings with sprinkler protection.

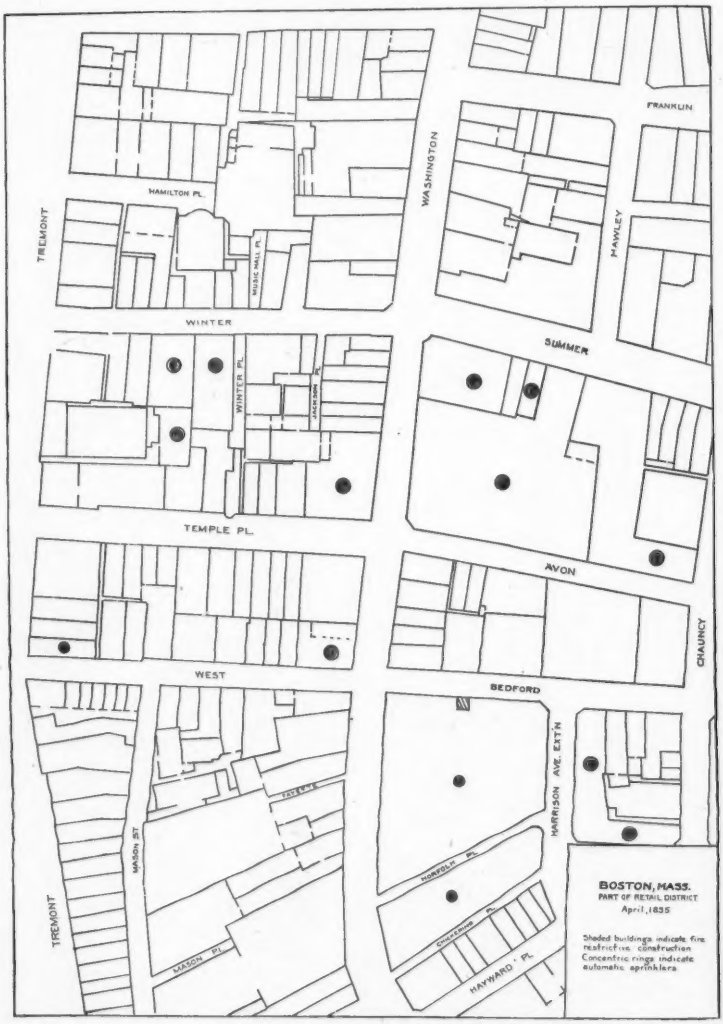
make way for betterments, there being little central vacant land, 206.

Note the proportion. The total number of permits issued in 1922 was 233% of those for 1914, but the number of first class permits was 1680% of the 1914 number, while 1922 second class were 166%, the *increase* in the first instance being 1580%, and in the latter only 66%.



The same district in April, 1922. Concentric rings indicate automatic sprinklers.

The larger part of this first and second class construction is in business districts. The general result of the new construction of 1922 and previous years may be realized when it is stated that there are now more than 350 buildings of first class construction in the central business district, more than 30 of which are also sprinklered. Some new districts are practically 100% fire-resistive construction. The number of buildings of



Part of Boston's retail district in April, 1895.

a given character is immaterial except as an index of progress but when the brief period of development of the modern American fire-resistive structure is considered and when it is realized how few years have passed since the erection of the pioneer building of that type in Boston, the record becomes impressive.

The finally perfected building ordinance for the City of London was enacted in 1687, twenty-one years after the "great fire" of 1666, but

The same district in April, 1922.

it was not until 1875, one hundred and eighty-eight years later, that the city proper was pronounced to be practically rebuilt in conformity to that ordinance. If the present rate of replacement continues in Boston, the business section, which corresponds to London City, should become entirely of fire-resistive construction within half the period required for rebuilding London, probably before the year 2000. This change may be

expected to come largely because of economic, rather than legal pressure. The comparison between London and Boston is apt because the original London was a wooden city, as much so perhaps as Chicago or Oshkosh, though probably much better built, and the London fire of 1666 raged largely in wooden structures. The preference for wood as a building material was strong and in one instance Parliament was memorialized in an address setting forth the comparative virtues of wood, including fire resistance.

In May 1922, the total number of automatic sprinkler installations in Boston exceeded 1260, of which some 1100 were "complete" and 160 "partial" (Boston Board of Fire Underwriters). The value of automatic sprinklers in suppressing fire and of sprinklered buildings as conflagration barriers needs no comment, it has been severely tested in Boston and has triumphed.

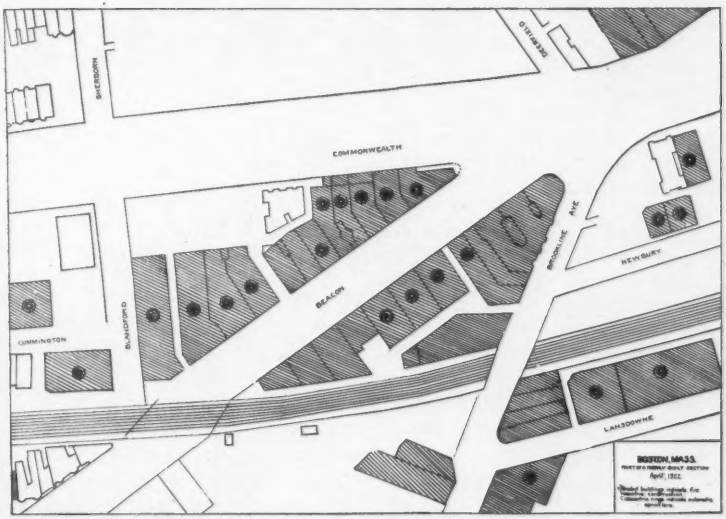
These fire-resistive and sprinklered buildings are largely ranged along the chief thoroughfares in such manner as to form practically continuous barriers subdividing the congested district of the city, which formerly formed a single conflagration area, into five well marked districts, between no two of which is it at all probable that any conflagration could pass, if a reasonable allowance be made for the probable value of the fire department.

There are three distinct systems of water service: low service, with 50-55 lbs. pressure; high service, 90 lbs.; and high pressure capable of 150 lbs.; the two first being gravity systems, the latter a direct pumping system. The business district is pretty thoroughly covered by all three, with large mains and an abundance of hydrants. Salt water can be used by the high pressure system should emergency require. The total water supply is such that, in event of a conflagration emergency in the business district, delivery of more than 60,000 gallons per minute could be made while maintaining the pressure at not less than 20 lbs. at all hydrants supplying fire engines. This estimate is confirmed as conservative by the Boston Water Department.

The fire department is of good size, well drilled and fully supplied with all needed apparatus, including special apparatus for high pressure service, such as swivel nozzles (deck guns) on trucks capable of delivering enormously powerful streams at high velocity. More than 60 pumping engines are available within the city and nearly as many more can be summoned from immediately surrounding suburbs. Three fire boats are also available as aid along the water front.

In all of this preparedness against the conflagration menace, mainly achieved within the past 20 years, Boston has apparently kept pace at least with other large cities and can at least lay claim fairly to be up to the average.

The accompanying maps of portions of the retail and financial districts showing the number and distribution of fire-resistive buildings and sprinkler equipments in 1895 and 1922 clearly portray the progress of 27 years (the entire district is too large to be reproduced on an intelligible scale), and a fifth indicates the trend of new construction. Water service cannot be shown on these small scale maps. It is quite probable that this rate of progress has been in specific instances much exceeded elsewhere



A newly built section of Boston in April, 1922, showing the trend of new construction.

for, presumably, Boston simply represents an average. In fact the Building Commissioner of Detroit in an instructive letter stated that new business construction in that city (five months of 1922) was practically 100% "fireproof," the sole exception being one small storage building.

It will probably be conceded that under modern conditions 100 years is a reasonable limit for the practical reconstruction of the average large city in its central district and that the conflagration proof city, or cities, may be held to be in sight.

It is true, however, that modern fire-resistive construction is large area construction and increases the possibility of conflagrations within the limit of four walls, equalling, in damage inflicted, a conflagration of former days of considerable territorial extent. This is, however, very largely compensated for by a wider application of the automatic sprinkler, which we may also expect.

The business district of Boston is subject to regular fire inspection by the inspectors of the Boston Board of Fire Underwriters, and a somewhat less regular and comprehensive one on the part of the Fire Marshal's office, in addition to which an extensive inspection scheme of uniformed members of the fire department is being put into operation.

Manifestly all of this inspection and improved construction and service must be reflected in the fire loss, but fire loss is always a matter of relativity and to be at all authentic must be based upon definite values which change annually. This is difficult to establish for a single city since it must, in this case, be fairly accurate, whereas if we were dealing with statistics of a hundred cities we could fall back on averages. Tax rates vary greatly in various communities while the relation of assessments to

real values varies still more and all tax assessments in cities are of necessity to some extent based upon economic rather than real values, assuming the real or intrinsic value to be the cost of reproduction less depreciation. Nevertheless the only way to approximate mass values is by means of the tax lists, and knowing the practice of any particular city as regards the proportion of real value assessed for taxation, a fair estimate is obtainable.

Boston assessments formerly represented about 42% of the appraised value (they are still well below that in some cities) but the basis has been gradually increased until it is set at about 66 2/3% of appraisal, an estimate which is well confirmed by comparison of a number of independent appraisals with the tax lists. Therefore the combustible value of Boston buildings may be reached by adding 50% to the assessment, to get cash value of buildings only, and by adding 150% more for general contents, personal property and stocks of merchandise, placing the total burnable value at 2½ times the assessment in normal times. In dealing with the past seven years (1914-1921), however, a liberal addition must be made for inflated values. Using the tax lists therefore we get the following:

	BURNABLE VALUE	Fire Loss	Fire Tax Rate (Dollars per Thousand of Burnable Values)	Population	Number of Fires	Per Capita Loss	Number of Buildings
1914	$1,286,780,750 (2½ times building values)	$3,044,626	$2.40	701,275	2319	$4.34	102,095
	$1,863,523,700 (3 times building values)	$4,017,158	$2.10	755,857	1910	$5.31	109,167

The increase of estimated combustible value as tabulated is 45% in eight years, or well below the normal 7½% annual normal average increase, certainly a conservative estimate. The increase of fire loss was 32%, and the decrease in the fire tax rate, 12.5%. The increase in population was 7½%, and increase in per capita loss 22.5%.

Losses in excess of $15,000 each in 1921 were 13% in excess of similar losses in 1914. The number of losses of less than $1,000 decreased 20%. The average loss per fire increased from $1,316.90 to $2,103.20, an increase of 60%. The number of fires fell off 17.6%, although the number of buildings increased by 7%.

These results are about what could have been predicted could the increase in fire-resistive construction, concentrations of values, and the increased activities of inspection have been foreseen.

Inspection ought to reduce fires numerically, particularly small fires, and, despite the increased number of buildings, the total number of fires fell off 17.6% and the number of small fires fell 20%. Concentration of values and larger area of new buildings should theoretically increase the average losses in the larger fires and losses of over $15,000 increased 13% while the decrease in the fire tax rate (loss per thousand dollars of burnable value) was 12½% from 1914 to 1922. The per capita loss increased 22½% in the same period for the simple reason that values increased faster than population. It would have probably gone higher had the average individual wealth increased as rapidly as it did in some of the more favored localities. In rapidly growing communities where increase of population exceeds increase of wealth per capita losses are of necessity lower.

In all of this, the change in the number and character of losses, the increase in gross volume and the decrease in the fire tax rate, the tabulation and analysis reflect what we know to be the general average. It also bears out the theoretical expectation, and rather strengthens the assumption that Boston is an "average" city, and that the changes in progress are universal although of course not uniform in all localities.

It may also help to emphasize the fact that reduction in volume of fire loss cannot be hoped for or expected until the reduction in the fire tax rate exceeds the percentage of increase in values, a condition practically impossible so long as the nation continues to be prosperous. It requires no mathematical expert to demonstrate the inevitable result if the volume of combustible material increases by from 7 to 9 per cent annually and the loss rate decreases by only a fraction of 1 per cent.

What has here been given may serve to explain the great forces operating to reduce our fire tax and to show the way in which they operate. It also shows the operation of forces tending to increase that tax, such, for instance, as the increase in size of individual losses, for losses in excess of $200,000 by a single fire (excluding territorially large conflagrations) were estimated only fifty years ago to represent less than 20% of the total fire loss, whereas they now represent over 30%, an increase in that class of 50% in this period. It is in this class, however, that we may expect restrictive measures to become progressively more efficient.

Revised Loss Statistics for 1921.

$495,406,012 is the final fire loss figure for 1921, according to the Actuarial Bureau of the National Board of Fire Underwriters (Member N. F. P. A.). This total figure, together with the detailed statistics given here, was made available to N. F. P. A. members by publication in the January 1923 issue of Safeguarding America Against Fire; the data is reprinted in the QUARTERLY in order that it may be available for convenient reference as a part of the permanent records of the N. F. P. A.

The fire loss in 1921 of $495,406,012 compares with a loss in 1918 of $353,878,876, an increase of nearly 30 per cent in three years. The stupendous 1921 fire loss figure means an average burning rate of $16 a second. The sum is equal to more than half the yearly interest on the public debt of the United States; it would have maintained the U. S. Navy

AMERICAN FIRE LOSSES COMPARED—1918-1921.

CAUSES.	RECORDED LOSS. 1918	1921
Matches—Smoking	$16,453,562	$25,992,033
Spontaneous Combustion	10,258,036	20,186,392
Defective Chimneys and Flues	11,985,782	14,801,581
Stoves, Furnaces, Boilers and Their Pipes	12,234,455	13,910,531
Electricity	20,780,307	12,723,209
Lightning	9,509,499	12,353,222
Sparks on Roofs	6,703,037	11,458,220
Petroleum and Its Products	6,471,119	9,420,343
Miscellaneous Known Causes	6,111,123	7,705,196
Sparks from Machinery	7,775,772	6,972,928
Sparks from Combustion	4,901,123	4,864,771
Hot Ashes and Coals, Open Fires	3,213,075	4,327,268
Open Lights	3,902,624	2,831,116
Incendiarism	2,985,541	2,488,976
Gas, Natural and Artificial	2,743,080	2,213,440
Explosions	3,197,807	1,980,274
Ignition of Hot Grease, Oil, Tar, Wax, Asphalt, etc.	1,024,637	1,597,851
Rubbish and Litter	446,973	1,235,319
Fireworks, Firecrackers, etc.	279,391	573,595
Steam and Hot Water Pipes	354,828	191,771
*Exposure (Including Conflagrations)	63,735,399	62,912,566
Unknown Cause	88,035,931	175,584,208
Total	$283,103,101	$396,324,810
25 Per Cent to Cover Unreported Losses	70,775,775	99,081,202
Grand Total	$353,878,876	$495,406,012

*Losses due to spreading fires originating from various causes.

for twelve months besides defraying all the costs of the Federal legislative department for a like period; it is a sum nearly double the total disbursements for Government pensions in 1921.

As will be seen from the accompanying table the order of importance of fire causes has changed quite markedly in the past three years. Matches-Smoking has moved from second to first place and is firmly entrenched in the latter. Spontaneous combustion has jumped from fifth place to second, defective chimneys and flues has moved up from fourth place to third, while Stoves, Furnaces, Boilers and Their Pipes has dropped from third place to fourth, and Electricity has dropped from first place to fifth.

The states which contributed most heavily to the 1921 fire loss were New York ($48,391,992), Pennsylvania ($26,448,569), Illinois ($24,765,-369), California ($19,968,460), Texas ($19,934,268) and Massachusetts ($17,641,183). There were thirteen states whose per capita contribution to the 1921 loss rose above the national figure of $4.54. These were Delaware, $11.26; New Hampshire, $6.47; California, $5.83; North Dakota, $5.74; Arizona, $5.66; Georgia, $4.80; South Dakota, $4.78; Maine, $4.69; Oregon, $4.69; Florida, $4.66; New York, $4.66; Montana, $4.64, and Massachusetts, $4.58. Vermont with $1.52 bore the lowest per capita loss for the year.

1922 Fire Loss Record.

The fire loss record of the year 1922 for the United States and Canada stands as the worst in the history of this continent, with the one exception, 1906, the San Francisco conflagration year. The estimated value of the property in the United States and Canada destroyed by fire during 1922, as compiled from the daily records of the *New York Journal of Commerce,* aggregate $410,889,350. This is an increase of some $77,000,000, or 23 per cent, over the abnormally bad figures of the previous year.

The monthly table of fire losses for the past three years is as follows, showing an unusually high average:

	1920	1921	1922
January	$37,012,750	$35,319,950	$38,663,000
February	26,631,500	25,888,850	29,304,300
March	27,597,701	28,581,100	39,910,750
April	22,108,750	22,178,900	31,009,750
May	25,440,300	23,956,800	29,868,950
June	25,745,900	29,000,700	24,102,850
July	25,135,825	33,355,750	36,667,750
August	17,930,800	25,829,000	21,579,500
September	25,630,050	26,502,400	41,515,000
October	28,331,100	27,955,350	40,065,400
November	28,093,350	26,178,600	30,776,100
December	41,197,600	28,907,550	47,426,000
Totals	$330,855,626	$333,654,950	$410,889.350

It should be realized that these *Journal of Commerce* figures, while furnishing a valuable basis of comparison, are lower than the actual fire loss as compiled from insurance loss reports. The statistics of the Actuarial Bureau of the National Board of Fire Underwriters for 1921 show a loss of $495,406,012 as compared with $333,654,950 for 1921 given by the *Journal of Commerce*. It seems highly probable, therefore, that the Actuarial Bureau's figures for 1922 will exceed $500,000,000.

The Record for Forty-four Years.

During the past forty-four years the aggregate fire waste of the United States and Canada, as compiled from the daily records of the *Journal of Commerce*, reached the enormous total of $8,077,372,745. The record by years since 1897 is as follows:

1922	$410,889,350	1900	$163,362,250
1921	333,654,950	1899	136,773,200
1920	330,856,625	1898	119,650,500
1919	269,000,775	1897	110,319,650
1918	317,014,385	1896	115,655,500
1917	267,273,140	1895	129,835,700
1916	231,442,995	1894	128,246,400
1915	182,836,200	1893	156,445,875
1914	235,591,350	1892	151,516,000
1913	224,728,350	1891	143,764,000
1912	225,320,900	1890	108,893,700
1911	234,337,250	1889	123,046,800
1910	234,470,650	1888	110,885,600
1909	203,649,200	1887	120,283,000
1908	238,562,250	1886	104,924,700
1907	215,671,250	1885	102,818,700
1906	459,710,000	1884	110,108,600
1905	175,193,800	1883	110,149,000
1904	252,554,050	1882	84,505,000
1903	156,195,700	1881	81,280,000
1902	149,260,850	1880	74,643,400
1901	164,347,450	1879	77,703,700
Total, 44 years			$8,077,372,745

Large Loss Fires in 1922.

The total number of fires causing loss of $10,000 or more during 1922 was 4,505. This compares with 4,068 in 1921 and 3,457 in 1920. The number of fires in the million dollar class was unusually large, being exactly twice as many as in 1921. Following is a list of these fires:

MONTH	LOCATION	DESCRIPTION	LOSS
January	Niagara Falls, N. Y.	High school	$1,000,000
January	Chicago, Ill.	Car barns	1,500,000
January	Allouez, Wis.	Ore docks	2,000,000
February	Montreal, Que.	Office building	1,000,000
March	Montreal, Que.	City hall	1,000,000
March	Quebec, Que.	Monastery	1,200,000
March	Chicago, Ill.	Business block	8,000,000
April	Monroe, Mich.	Container factory	1,000,000
April	Norfolk, Va.	Lumber mill	1,000,000
April	Kearney, N. J.	Railroad repair shop	1,000,000
May	Perth Amboy, N. J.	Lead plant	1,500,000
June	Kings County, Wash.	Forest fire	1,000,000
June	Pineville, Ore.	Wholesale district	1,000,000
June	Gladstone, Mich	Railroad shops	1,000,000

MONTH	LOCATION	DESCRIPTION	LOSS
June	Arverne, L. I.	Summer resort	$2,000,000
July	Baltimore, Md.	Grain elevator	5,000,000
July	Utah Junction, Col.	Railroad shops	1,000,000
July	Port Alfred, Que.	Pulp plant	1,000,000
July	McGill, Nev.	Copper concentrating plant	2,000,000
July	Beaumont, Tex.	Oil tanks	2,000,000
July	New York, N. Y.	Warehouse	1,500,000
July	Middletown, O.	Rolling mill	1,000,000
July	Prescott, Wash.	Flour mill	1,000,000
August	New York, N. Y.	Railroad pier	1,000,000
September	Napoleonville, La.	Sugar refinery	2,000,000
September	Sugar Pine, Cal.	Lumber mill	2,000,000
September	Terre Haute, Ind.	Hominy plant	3,000,000
September	New Orleans, La.	Warehouses and piers	5,000,000
September	Astoria, Ore.	Lumber mill	1,000,000
September	Madera County, Cal.	Forest fire	2,000,000
September	Indianapolis, Ind.	Grain elevator	1,000,000
September	Atlanta, Ga.	Stores	1,500,000
October	Northern Canada	Forest fires	15,000,000
November	Tulsa, Okla.	Oil wells	1,000,000
November	Humble, Tex.	Oil wells	1,500,000
November	Chicago, Ill.	Grain elevators	1,000,000
November	Bethlehem, Pa.	Fur manufacturing plant	1,000,000
November	Winnipeg, Man.	College	1,000,000
December	Terrebonne, Que.	Business district	1,000,000
December	Newbern, N. C.	Residences	2,500,000
December	Astoria, Ore.	Business section	8,000,000
December	Quebec, Que.	Church	1,000,000

Fire Losses in Canada.

Fire losses in Canada for 1922 set a new high record, exceeding the previous high record year, 1918. There was a loss of approximately $3,000,000 in the Northern Ontario disaster of October, and in other respects the losses for the year were unusual. The *Monetary Times* record for the past three years shows the following monthly losses:

MONTH	1920	1921	1922
January	$2,637,850	$2,237,900	$3,597,500
February	1,895,575	2,735,500	4,062,400
March	1,793,200	2,112,200	4,331,750
April	3,229,500	2,510,700	2,532,100
May	2,001,819	3,811,350	2,956,450
June	1,424,319	2,303,400	2,162,550
July	1,426,850	2,880,250	3,652,000
August	1,857,800	3,014,860	1,926,355
September	2,480,485	2,410,300	3,127,000
October	2,467,901	2,199,700	5,627,950
November	2,769,800	1,818,750	2,954,400
December	3,386,475	1,952,600	6,354,550
Totals	$27,371,574	$29,987,510	$43,285,005

Fire Losses in Great Britain.*

The fire loss in the United Kingdom during 1922 was in striking contrast with the losses of the United States and Canada. The grand total for the year was substantially smaller than that for either of the two preceding years. The following table gives the monthly fire loss record of the United Kingdom for the three years:

* Data from the *London Times*.

Month	1920	1921	1922
January	£303,000	£370,000	£1,285,000
February	694,000	350,000	477,000
March	506,500	425,000	505,000
April	479,500	643,000	347,000
May	1,120,000	936,000	792,000
June	806,000	780,000	454,500
July	619,000	820,000	415,700
August	561,000	1,070,000	281,700
September	940,000	750,000	345,000
October	1,155,000	620,000	305,000
November	500,000	475,000	510,900
December	805,000	525,000	443,600
Totals	£8,489,000	£7,764,000	£6,162,400

Deciphering Charred Records.

The Bureau of Standards has recently issued Scientific Paper No. 454 on Action of Charred Paper on the Photographic Plate and a Method of Deciphering Charred Records. The investigation was conducted by Raymond Davis, photographic technologist of the Bureau. The material studied was paper which had been subjected to heat in a closed container, the paper having been converted into black sheets of carbon and not to ashes, as would have happened had they burned in an open container.

Preliminary experiments with chemicals were conducted but these were unsuccessful. A sheet of the carbonized paper was then placed between two "fast" photographic plates and kept in the dark for two weeks. On development a very perfect copy of both the writing and the printing was obtained. The carbonized paper contains gases that fog the photographic plate but the charred ink acts as a protective screen, hindering escape of the gas, so that when the plate is developed it has been blackened where in contact with the charred paper except in those places occupied by the ink.

It was found that photographic plates of sensitiveness usually termed "medium" or "fast" are suitable for the purpose. Very slow plates, such as "process" and the enlarging and printing papers, are not suited for the purpose because of the comparative insensitiveness of these materials to the gases.

Experiments were tried with photographic films but "portrait film" showed no effect in 32 days and "super speed portrait film" only a slight effect in the same period.

Oil Fire Fighting.

A description of the methods used by the Midwest Refining Co. in extinguishing a recent oil well fire in the Salt Creek Field, Wyoming, may be of interest to other operators who are liable at any time to face a similar experience.

The well, known as No. 4-A, came in on September 18, 1922, and was producing at the rate of 2557 barrels a day, accompanied by terrific gas pressure. On the morning of September 23, a defective gate valve was being replaced and it was while this work was in progress that the well caught fire. The origin of the fire is still unknown. The boiler had previously been moved away from the well and had had no fire for hours.

The general superintendent of the producing department from Casper was in the field at the time and was in the office of the field superintendent when the fire call came in at 11 A. M. The superintendents started for the burning well immediately. Upon their arrival, they found the rig reduced to a pile of burning timbers and a roaring torch of oil and gas flaming above the well.

Of the seven men at work in the rig at the time the fire caught, four escaped with their lives, two of them unhurt, the third suffering a badly bruised knee, and the fourth a broken elbow. Of the three who were fatally burned, one lived to be taken to the hospital, another ran about 10 yards from the rig where he fell, and the third was prostrated at the well.

A large crowd soon gathered, attracted by the dense column of smoke rising from the well, among them practically all of the Midwest field foremen, who were called into conference at once with the general superintendent and field superintendent upon their arrival at the well. Plans were perfected immediately for putting out the fire, it being necessary to secure the requisite material and equipment from warehouses and various locations about the field while a large amount of work had to be done in as short a time as possible. The work, therefore, was apportioned among the foremen, each one taking as many of his own men as necessary in order to accomplish the task assigned him.

The farm foreman in whose district the well was located was put in charge of all operations, supervising the laying of extra water and gas lines, connecting boilers, tanks, pumps, etc.

In order to have sufficient volume of steam to combat the blaze, furnish power for pumps, etc., 12 boilers were ordered assembled and the assistant field superintendent was assigned the duty of gathering them from the main warehouse yard and various parts of the field and transporting them to the well as quickly as possible.

To secure an adequate water supply for filling the boilers and wetting

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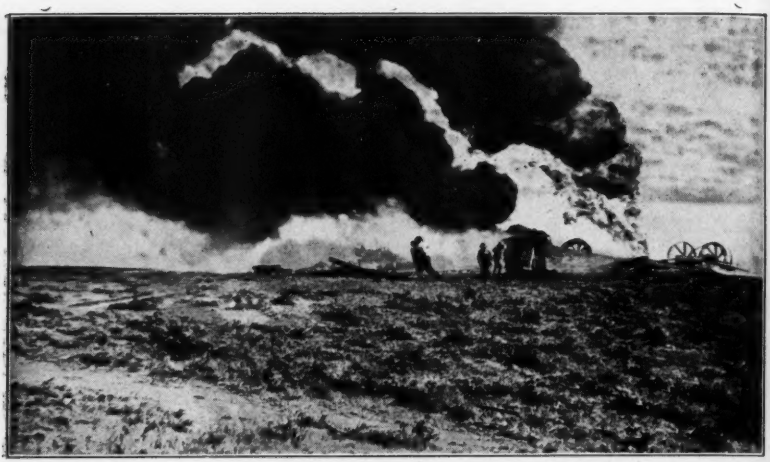
This article is printed through the courtesy of Mr. W. C. Platt (Member N. F. P. A.), Editor of the *National Petroleum News*.



Carrying away the body of one of the unfortunate men.

the debris and earth surrounding the well, it was decided not to depend on pipe lines alone, therefore, the farm foreman of an adjoining district was instructed to assemble four 250-barrel tanks, placing them adjacent to the boilers. In order to protect surrounding property, also to impound such oil as might accumulate after the fire was extinguished, earthen dykes were thrown up surrounding the well on the down hill side and were looked after by the same foreman.

It may readily be seen that in drawing field boilers from all parts of the field, new ones and old ones, that the filling and testing would be very important and the man selected for this work was the field boiler shop foreman who with his gang performed this task in a very short time. The duty of firing the boilers and keeping up steam was assigned to the chief tool pusher, who furnished enough men from his department to look after it. To him was also assigned the duty of guarding all properties after the fire was put out and until a new gate valve could be installed.

The intense heat made it impossible for men to approach near enough to the fire to clear away the debris. Shields 4 ft. x 8 ft. were therefore constructed by the rig building crew consisting of a frame work made of 2 x 4 in. lumber covered with corrugated sheet iron. These proved to be very effective, allowing the workers to approach much closer to the burning well than they could have done otherwise. To this crew was also assigned the duty of clearing away as much of the wreckage as possible about the well in order to prevent the hot metal from re-igniting the gas after the fire had been put out. Long poles were constructed of pipe with grappling hooks at one end for hooking into various pieces that were to be drawn away. Cable was attached to the opposite end of the pole and to a truck which pulled away the wreckage. The heavy parts of machinery which could not be moved, as well as all ground surrounding the well, were drenched by water from the hose line.

Night scene showing the boilers in place; the only illumination is the fire.

The furnishing of the necessary pipe fittings, valves, etc., for connecting boilers, pumps, and tanks, was no small item and the chief field warehouseman and his crew were kept very busy for a short time in its accomplishment.

The organization just described functioned perfectly and without hesitation. As previously stated, the well caught fire at 11 A. M. and by 1 P. M. from all quarters of the field, men, teams, trucks, boilers and material of all kinds were moving in the direction of the conflagration. Boilers were arranged side by side in a straight line about 100 yards distant from the well and were connected in batteries of four into a 4-inch header. From each header a 3-inch line extended to the well, making three 3-inch steam lines. There were also two 2-inch lines from the headers laid on the ground with nozzles close to the well. In order to get the nozzles of the 3-inch lines, which of necessity were 100 yards long, into proper position at the well, the front ends were lashed to a steel wagon axle with steel wheels. A gang of men then took up the rear end of these lines at a point far enough back for coolness and safety and pushed them forward into proper position at the well. Connection was then made into the 4-inch headers. Two high pressure pumps were connected to the four 250 barrel water tanks, pumping into the two hose lines which were put into operation in time to cool the ground as has been previously described.

At 2:30 A. M., just fifteen and one-half hours after the fire caught, with a pressure in the boilers of 125 pounds, the signal was given to turn on the steam. It is variously estimated that from 10 to 20 seconds were required from the time the first valve was opened until the fire was snuffed out. The fact is, however, that it simply required the few seconds necessary in order to have the full volume and pressure of steam effective at the point of contact with the gas.

The ground and all debris were sufficiently cool so that no re-ignition took place. A corps of men adequate to guard the premises and property were left on hand. The gate valve and control head were put in place without further difficulty after daylight. As this fire was extinguished while it was very dark, there were several automobile headlights and spotlights advantageously placed so that the men could see after the fire was put out. This proved to be a great help as, by contrast, it seemed exceptionally dark immediately after the big blaze was extinguished.

The success of the undertaking should be attributed to prompt organization, adequate equipment and a corps of men who understood just what they were to do and had the nerve to do it; however, no man was asked to risk his life or take any unnecessary chances. No accident of any kind occurred and as all crews were organized in shifts, the men were relieved and well fed so that no one was unnecessarily fatigued. The best of order prevailed and there was surprisingly little excitement,—it was all in the day's work.

Portable Pumps for Fighting Forest Fires.

During the past few years small combination gasoline engines and pumps have been developed for fighting forest fires with considerable success. The pumps at present manufactured for this purpose range from 85 to 200 pounds in weight and from $350 to $450 in cost. There are two types of pumps: the light single cylinder one man machine, and a two cylinder machine for two men or a pack horse. Both types can pump twenty gallons of water per minute against a head of from ninety to one hundred pounds.

These pumps seem to have given excellent service wherever used. The following is quoted from the British Columbia Forestry Branch Report which recently appeared in the *Pacific Coast Lumberman:*

Seventy-five portable pumps will be in service this season. Last year various improvements were made in this equipment with the result that it was used to a much greater extent than formerly both for fire-fighting purposes and for control of slash-burning fires. The department places great value on these pumps, and the 1921 report, recently issued, states: "There can be no doubt whatever that the use of this mechanical means of fire-suppression marks the greatest step forward in recent years in the work of forest protection." The total running time of the pumps last year was 2,400 hours, and it is estimated that 25,200 tons of water passed through them. To a greater extent than ever logging camp operators are adopting this means of fire-suppression, showing conclusively that it has passed the primary experimental stage and is now accepted as a necessary piece of equipment in a modern logging operation.

Mr. Roy Headley, Assistant Forester of the United States Forest Service, has the following to say regarding the use of these pumps:

We have perhaps a dozen small pumps in use throughout Montana, Idaho, Washington, Oregon and California. They are not called upon very frequently but they have a distinct part to play in forest fire protection. They are particularly valuable in handling fires in countries where the accumulation of litter is very heavy. These pumps are sometimes used in series—that is one pump will be used to elevate water through five hundred or a thousand feet of hose to a canvas tank from which another pump sends the water through another section of hose to another canvas tank or to the edge of the fire.

We have used or experimented with numerous other types of pumps, mostly hand power pumps. There are numerous pumps manufactured for tree spraying purposes, most of which work very well, theoretically at least, on a forest fire, but as a matter of fact none of these hand power pumps have attained what might be called a recognized place in the system of forest fire protection used on the National Forests.

The following statement is from Mr. G. M. Conzet, Chief of Field Administration of the Minnesota State Forest Service:

Regarding the use of light portable pump outfits for fighting forest fires: I think this is the greatest and best item added to forest fire fighting equipment. One of these pumps on our bad peat fires will do more work and better than twenty men. One ranger estimates a good pump outfit would be worth fifty men on any fire. This of course means we grant water is available within two thousand feet.

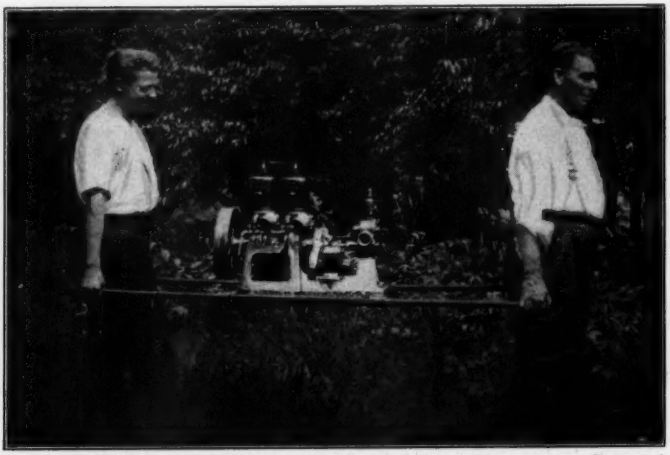
A paper presented by Mr. Henry Sorgius, Manager of the St. Maurice Forest Protective Association, to the North Eastern States Forest Fire Conference, which was held at Albany on February 25, 1920, gives some interesting data on the development of these pumps as follows:

The St. Maurice Forest Protective Association, Ltd., was formed in the year 1912 for the purpose of protecting the forest in the St. Maurice Valley, against fire. Through the experience obtained in combating the forest fires we came to the conclusion that the old-fashioned method of extinguishing fires, namely by using shovels, mattocks, gunnysacks, etc., was not by any means efficient for controlling and extinguishing a forest fire. It is only too true that an up-to-date system for discovering, locating and reporting fires is a very important factor to a forest protection organization, but of not much use, if we do not have the means to extinguish them after they have been discovered and located. When we had learned that Mr. Harkin, Commissioner for the Dominion Parks Branch, had been experimenting with a mechanical pumping apparatus for combating forest fires, we immediately acquired one of them and put it to practical use to supplement the old-fashioned equipment. This mechanical device consists of a pump directly connected with a gasoline engine. The engine is two cylinder, two cycle, water cooled and develops 4 to 5 H. P. The pump is a bronze rotary geared connected by a flexible coupling direct to engine and revolves at a maximum speed of about 1,200 revolutions per minute.

This pumping apparatus was designed by Mr. H. C. Johnson, Fire Inspector of the Board of Railway Commissioners of Canada, at the request of the Dominion Parks Branch. There were many factors to be taken into consideration and the chief one was the question of transportation in the woods, away from the railroads and good roads. There was also the question of getting the maximum quantity of water, from a certain source of supply delivered at a certain distance and at a certain height, which depends upon the power developed and which in turn is controlled by the amount of horse power it was possible to get out of the engine without affecting the fixed weight. That these difficulties were overcome will be understood when I give you the dimensions and weight of this apparatus.

The length of the engine and pump is 29½ inches, the width 17 inches, height 20½ inches and the total weight of engine and pump including aluminum base, wooden sub-base with handles for carrying, fuel tank containing one gallon of gasoline, is 136 pounds. The suction hose is 2 inches diameter, 8 feet long, fitted at one end with a coupling and at the other end with a strainer. The discharge used with this pump is 1,500 feet of 1½ inches diameter unlined linen hose with nozzle of ⅝-inch, and when running, throws a stream of water 30 to 50 feet from the nozzle. We found that the most practical way for transportation and use was to have the hose made up in 100 foot lengths.

This outfit will deliver at an elevation of 150 feet and after passing through 150 feet of hose 20 to 25 gallons of water per minute. It would have been easy to get a pump that would develop 5,000 pounds pressure, but we would have needed a railroad car to carry it around, and it could not have been used in the woods. This apparatus can be picked up by two men and carried anywhere a man can go. In an emergency one man alone can easily carry it along with a tumpline. It can



A portable pump which is capable of delivering twenty gallons of water per minute over a vertical distance of 200 feet and a horizontal distance of 1,500 feet.

also be easily loaded on an automobile, on motorspeeder or even motorcycle, in a gasoline power boat or on packhorses. Where there are numerous canoe routes it can easily be loaded in a canoe.

The question of water supply is a question that is largely governed by the locality. In the part of the Province of Quebec where we operate we can nearly always find water in the vicinity of a fire. We are not limited to one pump and 1,500 feet of hose, when water is further away from a fire than one pump can deliver it. We can use two or three pumps in relays. The first pump takes water from a creek, lake or river and pumps it as far as the pump will deliver it, which depends chiefly upon elevation, into a collapsible canvas tank or a similar container, and from this tank the second pump gets its supply of water and pumps it another 1,500 feet or as far as it will reach and so on until the fire is reached.

I may quote the following experiences we have had with this pumping outfit. We first tried it out at a fire in the summer of 1916 and used it the first season on four different occasions. We were at once convinced that the pumps would be a great source of help to fight forest fires, and would soon pay for themselves in the saving of labor, as they can easily replace 50 men with shovels, to say nothing of the saving of timber. A crew of men as a rule can only give efficient service during the early morning or late at night, when the fire is generally at its lowest ebb, while this pump can be kept going practically for twenty-four hours a day. On one occasion we used it for three days from 3 A. M. till 11 P. M. and experienced very little trouble with it.

We found it was necessary after the first season to have some minor changes made in the pump and since then we have had no trouble whatever to start it or keep it going. Since the first season we have purchased several of these outfits and now count them as one of our largest assets in fire fighting equipment. Some of the Companies who are members of our Association have also purchased pumping outfits and keep them at their storehouses and depots. On two occasions last summer these pumps were a great help in saving two large storehouses when a bushfire was threatening to destroy same. We find it also very economical to run, as it will run for one hour on a gallon of gasoline.

This pump could also be used for other purposes than actual fire fighting, such as backfiring and controlling slash burning operations.

Mr. R. L. Seaborne, speaking of this pump at the same conference, gives the following interesting description of its effective work:

At first the pumps met with a lot of criticism, but I found, while working on an old burn of 1901, which was very thick in dead and blown down timber, that with seven men I could cut 1½ miles of fire line, between 2 o'clock in the afternoon to 7 at night, as there was no grubbing to do, while 73 men working on the other side of the fire, cutting out a trail of the same width and grubbing it, and they were good too, supplied from an extra gang of the railroad, did not cut as much fire line. What is more we had to go over their line the next morning and put out fires left by them while our line had been well extinguished from the start. As far as I am concerned, water where at all available is the only thing to fight fires with. It is very easy to get men who know how to cut out trails, and they require little supervision, but it is not easy to get men who know how to fight fire, and who will grub a fire line properly. I do not know of a fire which has crossed a fire line, where the pump has been used.

These pumps are being used to advantage by the New York State Conservation Commission. We quote the following from an article on "Gasoline Pumps for Fighting Forest Fires," by Mr. William G. Howard, Assistant Superintendent of State Forests, New York.

It has been found that one of these pumps will soon pay for itself in the saving of labor, one pump being equivalent to from fifty to seventy-five men on the fire line. Moreover, when a ground fire burns down into the duff or humus it is impossible to extinguish it without a great deal of water that can only be secured by means of a pump like this or by a good heavy rain. Such a fire must be watched until it is entirely out, and if it can be put out in a day or so with a pump that is obviously much more economical than having to watch it for weeks, until there is a heavy rain: not to mention the quicker removal of the fire hazard.

An Unusual Loss of Life Report.

The following item was noted in the *New York Journal of Commerce:*

> Charleston, Ill., Feb. 4.—Fire which broke out in business section resulted in death of one man and caused damage estimated at $200,000.

Accordingly the N. F. P. A. Department of Fire Record sent a report form to the Illinois Inspection Bureau with the request that information be given on the fire with particular details as to loss of life. The report was duly received from Inspector C. H. Metzner (Member N. F. P. A.). In addition to the general information about the fire, Mr. Metzner added a postscript which read as follows:

"Upon investigation it was found that there were no lives lost as a direct result of the fire. However, a spectator, feeling the cold, became a little indiscreet as to what he drank, with the result that he died shortly after."

Solvent Recovery.

By W. D. Milne.
(Member N. F. P. A.)

The use of solvents in industrial processes is frequently attended by danger of fire and by danger to the health of workers. The solvents themselves, not remaining in the finished products, are frequently entirely lost or wasted.

The necessity for protecting the health and efficiency of workers exposed to the presence of the vapors of solvents has in a number of cases forced the provision of systems for the collection and disposal of the toxic vapors. Among the solvents the vapors of which have markedly deleterious effect are benzol, wood alcohol, and tetrachlorethane. Industrial laws in some localities have recognized the dangers from this source.

The large quantities of solvents evaporated in certain processes represent large values, and the possibility of recovering the solvents from their vapors has for many years attracted the interest of manufacturers. The successful recovery methods practiced in some industries and the constantly increasing cost of the solvents has led lately to increased attention being given to methods and devices available for effecting the reclamation of the solvents used in the rubber industry and the cloth coating industry.

While the particular inquiry from which the present discussion results centers about the application of solvent recovery systems to processes for the impregnating and coating of fabrics, the functioning of such systems in other industries may well be mentioned. In the manufacture of smokeless powder ether-alcohol solvent is used in large quantities, and the uniform drying conditions under which these volatiles are evaporated in large quantities present almost ideal circumstances for recovery operations. Such operations have been consistently carried on for a number of years. Likewise in the manufacture of nitrocellulose film, cellulose acetate dopes, and similar materials, various solvents such as methyl alcohol, acetone, ethyl acetate, and tetrachlorethane have been more or less successfully reclaimed. In artificial silk manufacture, processes for the recovery of ether, and of carbon bisulphide, have been used though perhaps under less favorable conditions on account of the limitations imposed by the manufacturing arrangements. Perhaps one of the earliest processes of this general nature to come to the attention of the fire prevention interests was that of reclaiming the alcohol from the shellac used in stiffening hats.

Gasoline and benzol are occasionally recovered after use in dry cleaning plants, turpentine and rosin extraction plants, degreasing plants, etc.

There are several processes of rather recent development, which, while they cannot be classed as solvent recovery operations, involve the

same fundamental materials and theories. Among these are several for the collection of gasoline from casinghead vapors of gas and oil wells, and from vapors escaping at refinery retorts, etc. The collection of benzol from retort coke oven gas, and the removal of water vapor from furnace blasts of steel work, are operations of a kindred nature.

Taken all together, there is a very considerable amount of practical experience with operations of this sort, but it is apparent that it is only lately that accumulated experience and sound scientific theory have been combined to secure reasonably satisfactory results. There are now several companies specializing in the design and installation of plants for the carrying on of solvent recovery and the other kindred operations enumerated above. There has lately appeared a book entitled "The Recovery of Volatile Solvents," by C. S. Robinson, in which the theory of the behavior of gases and vapors under various conditions is very fully discussed. A valuable feature of this book is its abstract of the literature and patents dealing with solvent recovery since 1881.

General Classification of Recovery Systems.

The principal systems now in use for the recovery of solvents may be classified in two different ways, first on the basis of the methods of capturing and conveying the atmosphere containing the vapor of the solvent, and second, on the basis of the method employed to extract the vapor of the solvent from the atmosphere in which it is present.

On the first basis the following systems are recognized:

1. Effecting direct recovery at or near the point of evaporation.
2. Conveying the vapor with air by means of forced draft to the recovery plant.
3. Conveying the vapor with an inert gas mixture to the recovery plant.

On the second basis the following systems are recognized:

1. Direct condensation by cooling.
2. Condensation by compression.
3. Absorption by solids.
4. Absorption or solution by liquids.
5. Combination systems using cooling, compression, heat interchange and absorption by liquids.

Before proceeding to descriptions of the actual systems now or lately in use, some consideration of the general classes listed above seems to be in order. It is quite evident that the manufacturing circumstances under which the solvent vapor is produced will considerably influence the choice of methods under the first basis of classification. It is also evident that the choice under the second classification will be influenced by the readiness with which any particular solvent will respond to treatment by the several agencies enumerated. A single solvent evaporated in high concentrations, condensing readily by simple cooling, may be largely recovered at small expense, while if the vapors of two solvents together with water vapor are mixed with a large proportion of air the recovery operation is complicated and expensive.

Certain solids, notably charcoal, and a special preparation from silicate of soda, have the remarkable property of absorbing selectively the vapor of one material from a mixture with other vapors. This principle is used in the construction of gas masks, and has been applied in solvent recovery. Various liquids have been employed to dissolve the vapors of solvents in recovery systems, among them being water, sulphuric acid, straw oil, mineral seal oil, and cresol. The particular behavior of the various solvents

and their vapors with respect to influences of cooling, compression absorption by other materials, etc., is beyond the province of this discussion. It is in order to say that ignorance of the laws governing the behavior of vapors and of the properties of the solvents themselves, combined with unfavorable conditions imposed by manufacturing arrangements, has led to some very costly failures in attempts to recover solvents. It has been chiefly in the more purely chemical operations involved in the manufacture of nitrocellulose products, where high concentrations of the vapor are possible, where there is little to interfere, and where technical knowledge is always available, that recovery processes have been successfully carried out.

Practically complete recovery of the solvent evaporated in any operation can be secured by using a combination of cooling, compression and absorption, especially in closed systems permitting of recirculation. It may frequently happen, however, that the extraction of a high percentage of the solvent from its vapor mixture entails plant and operating costs not warranted by the return, and more than one enterprise has failed on this account. In the application of solvent recovery processes to operations for the manufacture of rubber coated cloth, artificial leather, and various impregnated and coated fabrics, fires and explosions, together with other unsatisfactory conditions, have caused discouragement. The most serious bar to success of recovery operations in the manufacture of coated fabrics has been the interference of the principal manufacturing operation with the recovery operation, the impatience of the production department with the complications introduced by the recovery apparatus. Together with this has been an unwillingness to sufficiently provide for the operation and supervision of equipment not contributing to the principal production, and of unproven economy. The circumstance of the recovery enterprise in connection with this line of manufacture is far less favorable to safety and success than it is in the manufacture of smokeless powder and nitrocellulose products, where the recovery operation is more truly a part of the principal enterprise, and the technology of the whole is all in the same general field. The influence of this condition is clearly seen in a review of the actual experience with recovery operations.

Fire Hazards Involved in Recovery Operations.

Wherever a volatile inflammable liquid or its vapor is present serious fire and explosion hazards exist. The evaporation of such material in a manufacturing operation is always attended with danger. The introduction of solvent recovery operations, subjecting the solvent or its vapor to distillation, compression, condensation, etc., usually increases the chance of fire or explosion occurring. In any particular case, however, the question as to whether the total hazard of damage by fire or explosion is increased by the presence of the recovery system can only be decided after a very careful examination of the circumstances.

The facilities for collecting data in regard to actual installations of recovery systems in cloth coating and similar works has been limited. The fire record in connection with such installations is lamentably lacking both as regards completeness and as regards the details of essential features. Such data as have been available are here presented, together with comments as to hazards, as it is felt that the most satisfactory view of the whole matter may thus be shown.

Examples of Recovery Methods (with notes as to hazards).

DIRECT CONDENSATION TYPE: In the manufacture of imitation leather by the coating of fabric with nitro-cellulose compounds using a mixture of solvents including ethyl-acetate, benzol, and denatured alcohol, and others in some cases, wide and long machines for drying the work are employed. Successive coats are applied to the fabric by means of a roll and knife as on an ordinary spreader except that in some cases there is a knife at each end. Such machines are frequently 60 feet long and five feet or more wide. The vapors of the solvents used are very deleterious to health of employees and the provision of some means for their exclusion from the work room itself is important. This is accomplished in this particular patented device as follows: An enclosure of asbestos covered galvanized iron (or copper) is built up from the floor, completely enclosing the drying table except for the knife, with narrow slots to allow the passage of the fabric through it. At one side of the interior of the enclosure is a baffle wall shutting off a bank of cooling coils from the main enclosure except for draft passages at the top and bottom. The top or cover of the enclosure is provided with explosion hatches, in the form of panels resting in oil sealed grooves.

In operation, steam pipes under the fabric in the enclosure furnish heat to evaporate the solvents, and cause an upward draft. The cooling coils in the side compartment cause a downward draft, and there is thus established a circulatory motion of the vapor laden atmosphere in the enclosure. A condition approaching saturation is established and condensation of the solvent occurs at the cooling coils. The condensate, collecting in a trough at the bottom of the side compartment, is drawn off through a pipe.

It is quite apparent that when the machine is starting a time must occur when the mixture of vapor and air inside the machine is within the right proportion to permit explosion. It is also evident that after the concentration of vapors has increased to a mixture above the range of flammability, pockets containing an explosive atmosphere may remain. It is also possible that near the points where condensation occurs there may be a zone containing an explosive atmosphere. This explosion possibility is recognized by the designers of the apparatus, as is evidenced by the provision of explosion hatches.

The record of operation of this device is marked by numerous fires and explosions. Due either to the efficiency of the explosion hatches, or to the fact that the vapor mixture for maximum explosive force has not existed throughout the enclosure, the explosions apparently have not been as severe in their effect as might be possible. The frequency and severity of the explosions that have occurred would seem to warrant the branding of the contrivance as hazardous.

In a notable explosion in one of these machines, a minor explosion inside an enclosure lifted the hatches, allowing the escape of unburned vapor into the room, where a secondary explosion occurred demolishing the roof, and wrecking the sprinkler system. Four men in the room were badly burned.

In one large plant where there are some thirty machines, it is understood that the machines are isolated in pairs between fire walls, and while

explosions are said to occur every year, the damage done is probably restricted.

DIRECT CONDENSATION TYPE: For ordinary rubber spreading operations, a device, apparently developed in Germany and Sweden under stress of war conditions, has lately been offered to American manufacturers. In this contrivance a tight metal and glass enclosure is made over the top of the spreader tables from a point close behind the knife to and beyond the back end of the machine, and extending nearly to the floor under the rear half of the spreader table. Narrow slits permit entry and return of the fabric. The sides and bottom of the deeper rear part of the enclosure are water jacketed and a drain for the condensation is provided.

The principle on which this contrivance operates is the same as that in the foregoing case, condensation of the solvent occurring along the interior surfaces of the water jacketed portion, the condensate being piped away from a trough at the bottom.

Subject to certain modification on account of the size of the enclosures, and the methods of operation common with small flat spreaders, the explosion hazard of this form of apparatus is considered to be the same as that of the device previously described. It is evident that times will occur in the operation when an explosive atmosphere will exist inside the enclosed space. Field experience in America is still too limited for a satisfactory record as to fires to be obtained, but it is known that two explosions, said to have been of minor effect, have occurred in foreign installations. Explosion hatches, however, have been provided for the enclosure, according to plans, these hatches occupying one-third of the top area.

In the operation of flat spreaders on many classes of goods, it is frequently necessary to examine the goods beyond the knife. This means an opening of the enclosure, a considerable dilution of the atmosphere within thus interfering with the condensing, and introducing further possibility of an explosive condition being established. The possibility of the cooling water circulation being stopped, and pressure of vapor being built up within the enclosure, is recognized by the provision of an open sight feed for the water supply. The recovery obtained on such machines is said to be satisfactory, but its economy is evidently influenced by the cost of water provided for cooling, and upon the temperature at which water can be supplied, especially in summer. As with the previously described machine, much is made of the claim that the concentration of the vapors within the machine is such that explosion cannot occur. As previously noted such an assumption is incorrect, and proper safeguarding of such a device, if it must be used, should include adequate provisions for the limitation of the effects of an explosion.

DIRECT CONDENSATION TYPE: Sheeting calenders, on which a texture of rubber and asbestos or other fibre from a churned mixture with solvent is built up by accretion on a large heated calender roll, may be kept entirely closed except at the starting and stopping of the operations. Direct condensation of the solvent within enclosures around such rolls is accomplished by providing a water-cooled roll which runs against the material on the large calender roll. As in previous instances the condensate is simply piped away to a suitably located receiving tank.

In view of the nature of this machine and the method of its operation,

the chances of explosion occurring are materially less than with an enclosed flat spreader, since there is not the opportunity for flame originating outside to be carried into the enclosure. Once the machine is closed a possible cause for ignition inside the enclosure is difficult to perceive. Failure of the cooling water supply might cause the accumulation of inflammable vapors under pressure within the enclosure, and there would then be a very considerable danger of fire when the machine was opened, if not before.

When the covers of the machine are open the hazard presented is practically that of unenclosed machines used for the same purpose. The enclosure in this case appears to reduce rather than increase the hazard incident to the operation. Precautions that suggest themselves for adoption in connection with an enclosed machine of this type are that an independent open screen ended pipe vent be provided for the enclosure, and that a considerable part of the top area be constructed of oiled paper or cloth laid on a supporting wire screen.

A number of machines of this type have been in operation in American plants in the past year, and as far as can be learned have given satisfactory results and have experienced no fires.

AIR-CARRIED VAPOR TYPE WITH COMPRESSION AND COOLING: Solvent recovery operations at flat spreaders in two plants utilized a system developed for the production of gasoline from well casing head vapors, using primary compression, intercooling, and secondary compression with refrigeration effected by expansion of the vapors.

In these installations a simple hood was provided over the top of the spreader tables, the hood being connected by a draft pipe to the intake of the compressor of the recovery unit. A number of spreader hoods were connected to a header draft pipe located outside the building. The pipes were of heavy wrought iron. Balanced explosion valves or dampers were provided at dead ends and elbows on this pipe.

The recovery apparatus was cumbersome and expensive. The method of collection of the solvent vapors allowed very considerable dilution with air, and the work done in moving and compressing this dilute mixture was a constant source of expense from which no benefit was derived. Much of the solvent vapor was lost by reason of the spreader enclosure being incomplete. Both the installations proved to be rather costly failures and they are not now in operation. (Exact details as to the arrangement of these systems are not now available, but the foregoing is believed to be essentially correct.)

These systems presented a number of features worthy of note. The enclosure about the spreader was so incomplete that there was little danger of disruptive explosion occurring. The main draft pipe was well arranged and well located. The recovery units were, in both cases, well isolated so that considerable values were not exposed to such hazards as were present in connection with them. Apparently the removal of the vapors from the spreader lessened the number of spreader fires, although when fire occurred, as it did occasionally, the presence of the hoods caused some slight difficulty in extinguishing the blaze. The provision of fine mesh screens between the hood and the draft pipe would seem advisable in such apparatus to prevent a flash from being transmitted from the spreader to the draft pipe and thence throughout the system.

AIR-CARRIED VAPOR TYPE WITH CHARCOAL ABSORPTION: A recent installation for solvent recovery from flat spreaders is now in operation, though it may be considered as being still in the experimental stage and hardly tested by time. In this installation, fairly tight sheet metal enclosures have been built around five spreaders. Draft pipes connect the enclosures with a main header draft pipe of galvanized iron located outside the building. Fine mesh wire screen and a shut off damper are provided in each draft pipe above the spreaders. Suction is established by a motor driven fan located in a detached all steel building housing the recovery unit. The fan has soft metal blades and outboard bearings and is located between fine mesh screens. This fan delivers the vapor-air mixture to a large "absorber" in which there is a bed of specially prepared charcoal. The charcoal will effectively absorb the vapor from a considerable range of dilutions of the mixture for a certain period. After the charcoal has reached its absorptive capacity the vapors from the spreaders are diverted and high temperature live steam is turned into the bed of charcoal. The solvent is re-evaporated and passes on with the steam to a simple water tube condenser. The condensate (water and solvent) is collected in a receiving tank and the solvent, gasoline in this case, is drawn off from the top. The action of the live steam reactivates the charcoal and the absorption may then be resumed.

As do other absorption systems, this one accommodates itself fairly readily to fluctuations in the concentration of the vapor-air mixture caused by the necessarily frequent opening of the enclosure at the spreaders for examinations of the work.

There is no satisfactory means of preventing explosive mixtures of air and vapor from being present at times either in the spreader enclosure or in the draft pipe system and explosions in one or the other may occur. The screens noted have been provided with a view to limiting the extent of such an explosion and preventing the flash from extending from one spreader enclosure to another. Ready relief for an explosion within the enclosure is provided for by means of hinged side doors and an open space near the floor. While it is somewhat of a question as to how severe an explosion within these enclosures would be in its effect, the danger of a secondary explosion from unburned vapors escaping into the room is materially lessened by the dilution effected by the positive draft.

The recovery unit in this installation is open to criticism as a coal fired superheater boiler is placed in the same room with the absorber and condenser. Electric wiring and switches are open and the condenser, which may under certain circumstances be subjected to steam pressure, is not equipped with relief valve. The recovery building itself is insufficiently detached, being only some fifteen feet from the frame boiler house of the mill. Dangerous vapors are at times during the operation discharged from the absorber and probably from the condenser vent.

Although, as noted, this system may work at times in a range of mixtures in which explosion can occur, its hazard is not apparently as great as in the case of the direct condensation systems. If the fine mesh screens are not located and maintained with extreme care, and the explosion vents are not ample and reliable, explosion may cause considerable demolition, in the apparatus at least. The system is one which, if used, should be protected with great care against those ordinary causes which

so frequently give rise to spreader fires. Unfortunately in this installation the precautions against static discharges have been neglected. The safety of this system also suffers from ignorance and carelessness of employees unfamiliar with it as evidenced by a recent fire at the barrel where recovered solvent was collected. Apparently an employee had been smoking too near it.

AIR-CARRIED VAPOR TYPE WITH CRESOL ABSORPTION: In a large manufactory of imitation leather and coated fabrics, in which nitro cellulose compounds are dissolved in ethyl acetate, benzol, alcohol and similar solvents and spread on the cloth by large rotating machines, a system of solvent recovery has been used with considerable safety and success for some time, following a series of experiments extending over some fifteen years. In this installation the large spreaders are housed in wooden enclosures having sloping tops consisting of hinged panels or doors to serve as explosion hatches. These panels are secured by pasted strips of cloth to seal the joints. The draft pipe from each enclosure contains fine mesh screens and a wooden bladed fan. The several individual draft pipes run to a header and main draft pipe which carries the vapor-air mixture from the spreader enclosures to the recovery unit. This pipe is equipped with fine mesh screens, offsets and explosion hatches at critical points. The recovery unit is in a well-detached building. The general description of the recovery plant and its operation is as follows: The vapors of the solvent, mixed with air or other gas, are introduced at the bottom of a scrubber, in which they flow upward through a descending stream of (cresol) absorbent. From the top of the scrubber they go to the bottom of another, again passing upward through descending fresh absorbent. The air, now stripped of solvent vapor, is discharged. The absorbent, introduced by a pump at the top of the final scrubber, flows counter to the direction of the vapor through the scrubbers, and is then pumped to a feed tank. Thence, it flows through a heat exchanger, where its temperature is raised. It then goes to a still, where it is stripped of the collected solvent. The hot reactivated absorbent returns through the heat exchanger and absorbent cooler to the supply tank and is used again. The solvent vapor from the still is condensed in water-cooled apparatus, rectified, and discharged to storage.

This installation is an example of the application of scientific engineering to the solution of a difficult problem and also of the exercise of considerable care in attention to details. Several features in connection with it deserve special comment. The use of wood in the enclosures is believed by the owners to be much safer than metal in that the wood offers less opportunity for the discharge of static electricity between the goods or the vapor cloud and the enclosure itself. As the use of metal in the construction of such enclosures predominates, it is interesting to note the strong preference in this case for wood, after a long experience. The enclosures are equipped with sprinklers inside.

The grounding of all parts of the spreader, including the steam pipes, is very carefully attended to, the grounds being made to water pipes or to rods driven into the ground. Metal plates grounded with the machines are provided in front of the machines. Belts and shafting are provided with brushes to remove static charge steadily.

The speed of belts and shafting is kept very low.

The screens in the draft pipe isolate the fan and shut off each machine from the header. They are said to be of 120 mesh gauze and are properly supported and secured.

The use of individual fans for the enclosures insures a uniform and measurable draft so that the ordinary vapor concentration can be fairly well established.

The entire electric equipment is provided with a view to the elimination from the work room of possible open sparks from switches or elsewhere on such equipment.

While the possibility of explosion in the spreader enclosures cannot be denied, the precautions which have been taken and the extreme care which is exercised in the operations give a considerable sense of security in regard to this installation. With the exception of some slight trouble caused by lightning in one instance the equipment has given no trouble from fires.

AIR-CARRIED VAPOR TYPE WITH CONDENSATION BY COOLING: In one relatively small installation where rubber-asbestos sheet packing is made on a sheeting calender, the calender is enclosed except at the front on feed roll and a draft pipe is taken off at the back. The vapors of the solvent (gasoline) are drawn off by means of a fan in this pipe and delivered through a water-cooled condenser having a free vent to the air. The solvent collecting in the condenser floats on the water condensed with it and is drawn off from the top. The arrangement is crude, but simple, and as the solvent vapors are given off in considerable quantity and are fairly concentrated, a fair proportion of the solvent is recovered with slight expense. The safety of this system could be increased by the use of a proper fan and the insertion of fine mesh screens at certain points. The condenser also should preferably be outside the work room. Except for the condenser there is no large or tight enclosure to permit of a serious explosion. The hazards in an installation for one machine as in this case does not seem materially different from that of the unenclosed machine. If several calenders were connected into one system the hazard might be somewhat increased.

No particular trouble as to fires involving recovery apparatus at machines of this sort has been recorded, apparently, and it is understood that in England, where the practice originated, the experience has been satisfactory.

VAPORS CARRIED BY INERT GASES: As far as known there is only one highly developed system for utilizing inert gases in systems for the recovery of industrial solvents from their vapors. This is more familiarly known as the flue gas method. It is the only one designed specifically with a view to establishing safe conditions in the space where the solvents are evaporated and at the same time effecting efficient recovery. It has been developed on scientific principles and has been practically applied in a number of industrial processes.

In brief this system consists of three parts: first, a unit consisting of a furnace for the production of the flue gas from burning oil or coke, a scrubber, and a cooler; second, a reasonably tight enclosure about the space where the solvent is to be evaporated; and third, a recovery plant when the solvent may be secured by cooling, compression, absorption, or by a combination of these agencies.

In operation, a flue gas containing a known and regulated proportion of oxygen together with carbon dioxide, nitrogen, etc., is produced, scrubbed clean of soot and other impurities, and cooled. The production is so regulated that the proportion of oxygen present is considerably below that necessary to support any combustion. The enclosure where the solvent is to be evaporated is flooded with this inert gas before evaporation begins, so that the vapors pass into an inert atmosphere. The mixture thus formed is drawn by the action of the compressor into the recovery unit where the solvent is extracted. The inert gas carrying some residual solvent vapor is then returned to the system through the cooler, in whole or in part. This re-circulation allows economy in the production of the flue gas, and allows practically all the solvent vapor to be retained in the system. A balanced condition of operation is set up so that the proportion of the constituents of the inert atmosphere in the drying enclosure becomes almost constant. The safety of the system depends on the precision with which the proportion of oxygen in the atmosphere within it is controlled. This is insured by the provision of proper equipment for measuring the constituents and constant supervision by a skilled attendant. Such systems are the only ones of which it may be said with any confidence that they actually reduce the hazards of fire and explosions in connection with the evaporation of solvents and with the recovery thereof, and even these are subject to hazard if there is failure in the element of human supervision and control. This feature is emphasized by the fact that a serious explosion and fire loss occurred in connection with one of these systems at a time when the manufacturing was proceeding and the recovery system was not in operation. In this case explosion apparently occurred outside the enclosure due to vapors escaping from it.

These systems operate most satisfactorily where a high concentration of vapor is obtained. The percentage of recovery that can be obtained is high, the degree depending on the equipment that is provided in the recovery unit itself.

Suggested Precautions.

Not all the variations in special systems for solvent recovery have been described in the preceding paragraphs but enough illustrations have been given to show the essential features that may be involved. In considering the safeguards that may be provided in these operations it is necessary to go back somewhat to the principles established in the previous work and reports of the N. F. P. A. Committee on Manufacturing Risks and Special Hazards in regard to rubber mill churn and spreader rooms. There are certain arrangements as to construction, ventilation, lighting, grounding, humidification and protection which are essential for the assurance of a reasonable degree of safety in churn and spreader rooms. Where solvent recovery is practiced or the spreaders, impregnating machines, or similar apparatuses are enclosed, these features become of still greater importance. It is especially important that all causes for fire be eliminated in as far as possible, for if fire is carried into an enclosure where inflammable vapors are present with air, an explosion is very likely to result. While it may be true that some of the systems here considered reduce the frequency of minor spreader fires, they may at the same time introduce the possibility of more serious occurrences.

The danger from fires in spreader rooms and similar areas may be reduced by the following means:

(1) By the provision of high studded, roomy construction.

(2) By the provision of effective constant natural ventilation for the entire space in the room, both at ceiling and floor level, or if necessary, by the provision of safe means of artificial ventilation to secure the equivalent results.

(3) By providing safe electrical equipment, the equipment to be in accordance with the standard rules for hazardous locations.

(4) By providing means to regulate the humidity in the room.

(5) By using slow moving pulleys, belts and especially slow moving machines for coating or impregnating.

(6) By providing permanent, substantial and positive grounds for the elimination of static electric charges from all points where they may tend to collect. This precaution should be taken with exceptional care at all machines where evaporation of solvent occurs.

The enclosures about the machines or drying areas where the solvents are evaporated, since they must be in manufacturing areas, are very important factors, for if fire or explosion occur within them the damage to the surrounding property may be considerable.

It seems essential to safety that there should be a minimum of resistance offered by the enclosure structure to the force of an explosion within. Light materials such as glazed paper, cloth or plaster board, or preferably, incombustible material supported on wire netting, seem desirable. Hinged covers or covers laid in place and sealed with paper should be provided over the maximum possible area to afford explosion relief.

Each very large enclosure or tight enclosure around a machine where direct condensation is to be carried on, should be in a well cut off section, and there should be external windows on at least two sides of the room. The ceiling of the room should be high and provided with a monitor.

The use of apparatus of the direct condensation type entails a relatively high explosion hazard and the buildings housing such equipment should be especially arranged and designed.

Automatic sprinklers should be provided within machine enclosures. Main sprinkler feed pipes and branch lines should be so located as to avoid their being damaged in event of an explosion.

Carefully designed and substantially constructed fine mesh gauze screens should be provided in the draft pipe through which the vapors, etc., are drawn from an enclosure. Screens should be likewise provided to isolate any fan that is used for moving the vapor.

Where there are several enclosures connecting into one system provisions should be made to insure that there is an equable distribution of the draft over all the enclosures.

Draft pipes should run as directly as possible outdoors. Large draft pipes within a building should be avoided.

Fans used for moving the vapors should be specially constructed for the service. Fans with soft metal blades and running rings, and outboard bearings, are obtainable for this use. Fan shafts, fan casings, and fan motors should be grounded to a common ground with the structure of the machine and its enclosure. The wiring and controls for the motor, and the motor itself, should all be of the type suitable for use in hazardous

locations. Steam or air turbine operated fans are safer than motor driven ones.

The recovery plant proper should be located at least 50 ft. and preferably 100 ft. from all other structures, depending on the size of the plant and the value and hazards of the exposed buildings.

The building housing the recovery unit should be of non-flammable or fire-resistive construction. All possibility of open flame or spark within it, or near it, should be eliminated. The entire electrical equipment within it should be standard for a hazardous location, and all parts of the structure and its equipment should be thoroughly grounded.

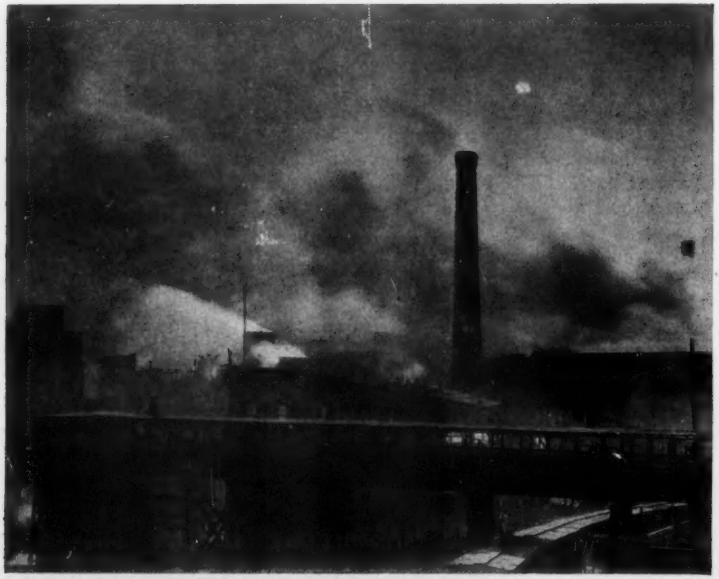
The entire equipment should be in charge of an exceptionally capable man, who should thoroughly understand the hazards and the precautions that they make necessary. There should be complete harmony and coordination between those in charge of the recovery apparatus and those in charge of the manufacturing.

Conclusions.

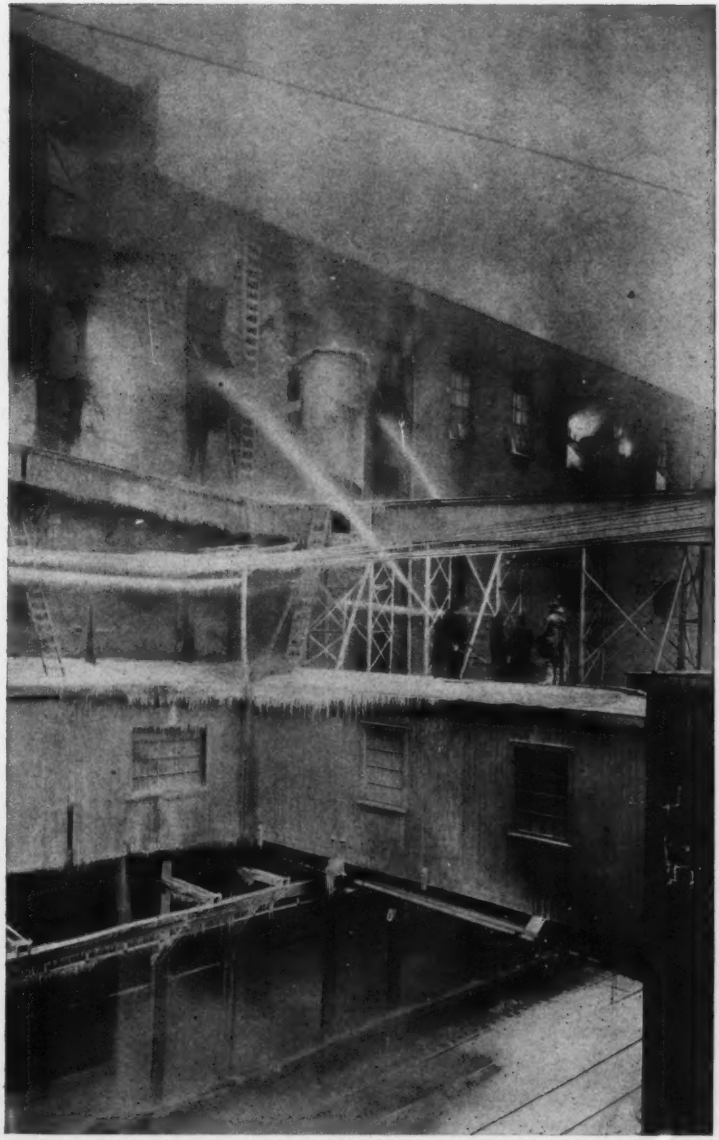
There is no single feature more likely to give trouble than static electricity and thorough provisions must be made and maintained to reduce the hazard from this source. It is interesting to note in this connection an announcement recently made that X-rays and ultra violet light will immediately disperse any charge of static electricity, and that use of this fact would be made in safety appliances on dusty machines and others where static charges made trouble. Another interesting device for reducing the hazard from inflammable vapors has recently been developed. This device consists of an electrically heated filament, coil, or element of a catalyst, enclosed within a fine mesh wire screen similar to that of a miner's lamp. It is designed to oxidize the inflammable vapor inside the gauze screen, either by combustion or the action of the catalyst, and is proposed for use in preventing the accumulation of dangerous vapors in manholes, vaults, and other enclosed places.

The introduction of rubber latex and the use of dispersed rubber in water solutions, doing away with the use of benzol, naphtha, and similar solvents, may eliminate many present churn and impregnating process hazards. Constant research and experimentation may finally result in a great reduction in the hazards now attending the manufacturing operations here considered, but for the present reliance must be placed in those precautions which experience has shown are effective and necessary.

The recovery of solvents in the coated fabric industry seems at present to be a venture of rather doubtful financial success, where it is carried on for direct profit alone. Where toxic vapors accompany the manufacture, the solvent recovery appears to be fully justified. The intricacies of the problem are such that any manufacturer should examine closely into the experiences and knowledge of his advisers in regard to such matters before committing himself to an undertaking in solvent recovery. Once committed to it he must be willing to give the recovery operations the benefit of skilled attendance and the right to carry on without too constant surrender to the exigencies of the purely manufacturing operations. Once installed a recovery system should be kept constantly in operation while the manufacturing operations continue, for if it does not function, serious hazards may be present.



The Armour packing plant fire at Omaha, February 14, 1923. The fire, which was of unknown origin, gained considerable headway before it was discovered. (Also see Frontispiece.)



Courtesy of Frank Stanbery, Nebraska Inspection Bureau, Member N. F. P. A.

Zero weather and a strong northwest wind hampered the firemen at the Armour fire. Owing to weak water pressure it was thirty minutes before good hose streams were available. **(See opposite page.)**

Three large sections of the Armour plant at Omaha burned for three days. Twenty-two dry pipe sprinkler systems in these sections could not control the fire. The firemen were unable to get water at the base of the fire. (See also pages 358, 359.)

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Weed Killers.

It is desirable from the fire prevention standpoint that factory premises, lumber yards, and the like be free from heavy growths of weeds and grass. That N. F. P. A. members are interested in this subject is evidenced by the frequent inquiries received at the Executive Office for methods of removal of weeds and grass. The removal of this growth by hand is a costly and tedious process, and must be repeated at frequent intervals to be effective. The chemical weed killers commonly used will perform the work more quickly and easily and in most cases at less expense. The results also are more or less permanent as two applications the first year and one or two lighter applications each subsequent year will maintain the surface clear of vegetation for an indefinite period.

The following data is taken largely from a bulletin on Chemical Weed Killers, issued by the Bureau of Plant Industry of the United States Department of Agriculture. During the past ten years this department has tested a large number of chemicals, most of which have proved ineffective or have been too costly or too difficult to obtain for ordinary use. The list includes among others, steam, hot water, carbolic acid and other coal tar products, iron sulphate, copper sulphate, sodium nitrate, copper nitrate, mercuric chloride, formaldehyde, carbon bisulphide, sulphuric acid, nitric acid, ammonia, a variety of the salts of arsenic, calcium and hydrogen cyanide.

Three substances have been found which are generally satisfactory, namely sodium arsenite, oil, and common salt.

Sodium Arsenite.

Sodium arsenite is the most powerful plant poison known and it may be considered the standard chemical for killing weeds. It is an active constituent of practically all proprietary "weed killers" and is used in large quantities by railroads, municipalities, and others. It should be remembered, however, that arsenic and all its compounds are deadly poisons when taken internally. This means that the utmost care is necessary in handling the material and in making sure that the treated area is not played on by children or grazed by animals for several days after the treatment. Efforts have been made to find a substance which would make sodium arsenite repellant to livestock, but without much success. The chemical should not be handled with the bare hands, nor should the dust or vapor be inhaled or the liquid allowed to spatter on the person.

Sodium arsenite is rather difficult to obtain ready-made, as it is carried in stock only by the larger wholesale druggists and manufacturing chemists. The manufactured article is a white or grayish powder which is not uniform in composition and quality and cannot be depended upon for weed killing unless made especially for that purpose. When purchased in this form, sodium arsenite should analyze at least 90% anhydrous

sodium arsenite and should not be confused with the more common but less effective sodium arsenate. Sodium arsenite should be used while fresh, as it oxidizes readily and hardens when exposed to the air for several weeks.

Commercial "weed-killers" are usually strong solutions of sodium arsenite combined with various oils, salts and coloring matter. They are high in price for the amount of sodium arsenite they contain, but are usually of good quality and give satisfactory results when used according to the maker's directions.

If it is desired the sodium arsenite can be prepared locally and at a cost cheaper than the commercial weed killers or prepared arsenite. Formulas and directions may be obtained from the U. S. Department of Agriculture.

The weed killing solution should be prepared in the proportion of five gallons of sodium arsenite to fifty gallons of water. The amount of weed-killing solution to use per given area depends upon the character and size of vegetation, the weather, and the method of application. For average conditions, where the vegetation consists of mixed grasses and weeds not over 6 inches high, and where the soil is fairly moist, 600 gallons of the weed-killing solution are required per acre (1 acre equals 43,560 square feet). On this basis, 5 pounds of prepared sodium arsenite would make sufficient weed-killing solution to cover an area of 60x60 feet.

Chemical weed killers give the best results on a cloudy, humid day, when rain is not expected within 12 hours. In hot, dry weather the solution evaporates too rapidly. Treatment should not be given while the soil is wet, but in case the soil is very dry, it should be moistened slightly to prevent the chemical from soaking in too rapidly. When the vegetation is large, it should be mowed before treatment, both to save material and to permit the chemical to penetrate to the soil. After mowing it is well to wait several days before treatment to allow the vegetation partially to resume growth and exhaust the roots.

For ordinary purposes, a sprinkling can, a small watering cart, or a garden hose and nozzle fastened to a force pump is the most convenient equipment for applying the poison. A spray pump, such as is used for applying insecticides and fungicides, does not discharge rapidly enough. Railroad companies use special trains fitted with an elaborate arrangement of pumps and tanks for treating their roadbeds.

Oils.

The various petroleum oils are effective weed killers and have been used for this purpose in some cases. The hazard of oil soaked vegetation around a factory would preclude the use of oil for all ordinary conditions. The principal use for oils is on roads and railroads, where they act in the dual capacity of weed killers and dust layers.

Salt.

Common salt has been used for weed killing, but the effect of salt is not so lasting as that of sodium arsenite and the bulk of material that must be handled makes it objectionable for large scale operations.

Salt is applied either dry or in solution. Dry salt is used at the rate of three to ten tons per acre, depending on the thickness and character of

the vegetation. This application need not be repeated more than once in three or four years. The solution of salt is made as concentrated as possible (about 3 1/3 pounds per gallon) and is applied at the rate of 250-400 gallons per acre, in the same manner as sodium arsenite. There is no particular advantage in having the brine heated.

Other Chemicals.

The North Dakota Experiment Station of the Bureau of Plant Industry carried out some successful experiments with a 10 per cent solution of copper sulphate (blue vitriol) a few years ago. Iron sulphate (copperas) prepared in a solution of 1½ pounds per gallon of water has also been successfully used. Calcium chloride is another common chemical which has been used for this purpose.

Waste chemicals from industrial works can sometimes be obtained at small cost and are then of some use for weed killing. Most waste chemicals, however, are very inert and the ground must, therefore, be covered with a thick layer of the material to obtain the desired results. This makes their use impracticable where freight rates are high; furthermore, the thick layer of chemical interferes with any use that may be desired of the area.

Cats and Other Curious Explosion Causes.

By Augustus H. Gill.

The enormous and ever-increasing use of gasoline and of hydrocarbon gases has caused many mysterious and disastrous explosions and fires. The reports of these are widely scattered throughout the daily press, and are more or less distorted and exaggerated, but very few get into scientific literature.

This article is a study and investigation of some of the typical and well-authenticated cases combined with a plausible or perhaps probable explanation of their cause. It may be useful to those who from time to time have occasion to look into such matters, particularly in connection with legal cases.

One of the most mysterious of these fires, which was attended with fatal results, was the "Hair-Dresser's Accident" of June 26, 1897, in London. A petroleum hair wash was being applied as a shampoo when it suddenly ignited, burning the woman. Bearing in mind the familiar experience of lighting gas by shuffling across a rug and applying the knuckle to the open gas jet, there is no doubt but that frictional electricity was here generated in sufficient quantity to ignite the petroleum vapor. It has been reported from New York that a woman recently set fire to her hair by an electric spark while walking on a Brussels carpet, after indulging in a shampoo containing alcohol. The electrophorus, after being rubbed with a catskin, is sometimes used to explode gaseous mixtures in the small Hempel gas-explosion pipet. Inasmuch as ordinary

Courtesy of *Industrial and Engineering Chemistry.*

ether is a constituent of hair washes at the present time, it seems that they should be rendered nonflammable by mixing with chloroform—or better, when applied, the patient should grasp a metal handle which should be carefully grounded.

An automobile was destroyed and its owner, a naval surgeon, severely burned, through the firing of the gasoline by a spark produced by frictional electricity. The surgeon had walked some distance to his garage in his fur coat and rubber boots. The friction of the flapping coat against his boots generated the electricity, while they insulated him from the ground and allowed his body to store it. The spark went hence through the grounded automobile igniting the gasoline.

A silk dress that had just been cleaned by gasoline was removed from a basket. This movement of the silk generated an electric spark that fired the gasoline vapor still remaining in the dress after cleaning. The dress and other nearby garments were burned. When woolen fabrics are washed in ether or gasoline, they become electrically charged. This charge is so great as to produce sparks when touched by a person.

It has been demonstrated beyond question that when gasoline is pumped through hose, frictional or static electricity is generated—under certain circumstances a pressure of 400 to 500 volts has been generated. Even when poured through chamois skin dangerous sparks have been produced. The chamois strainer should be replaced by 80- to 90-mesh wire gauze which will exclude water when first wetted with clear gasoline. This generation of electricity has been shown repeatedly, but one example will illustrate: A chauffeur hung an ordinary 5-gallon can on the hook of a common gasoline pump. The bail of the can had a wooden handle which insulated the can from the pump. A gallon had been pumped when a spark jumped from the can to the pump and fired the gasoline. After putting out the fire—as it was desired to fill a car, and the reason for the fire not being understood—the filling of the can was repeated and it caught fire a second time.

In filling a can or motor-car tank, care must be taken that good metallic contact is made between the nozzle of the hose and the article filled. If a funnel is used, it should not be blocked up with wood or paper, but metallic contact should be made. A chain or wire should connect the hose nozzle with the filling tank so that all electricity generated may pass to the ground as it is produced.

Gas Explosions.

The explanation given of the cause of the hair-dresser's accident—the generation of frictional or static electricity by rubbing of hair or fur—will undoubtedly explain the two following incidents:

It is the custom of dog (and cat) catchers to asphyxiate their catch in a "tank" or "dispatch" with ordinary illuminating gas. In 1914 the dog officer in Providence threw a cat into the lethal tank; on turning on the gas it exploded, singeing the officer's hair and injuring another. This was the third time such an accident had occurred—many dogs had been disposed of without trouble.

In New York the Society for the Prevention of Cruelty to Animals reports that in the course of twenty-five years there have been half a

dozen minor explosions; the last one, however, was so serious that they have decided to adopt other means.

Their "dispatch" was a steel tank 10x4x4 ft.; on the top were two covers of heavy plate glass set in steel frames and capable of being firmly fastened down. Thin lids covered the holes through which the animals were passed into this asphyxiator; the usual charge was about six cubic yards of cats. It was customary to charge it somewhat with illuminating gas and drop the victims into it, that they might be killed as quickly as possible.

On the afternoon in question three basketsful of cats had been put in, one of the glass covers being held up by an attendant. Basket four contained, among others, a black "fighting Tom." Several of his companions dropped without trouble, but he wanted to stay where he was. He dug his claws into the wickerwork and hung on, even holding another cat against the side of the basket. It was put down to the very mouth of the hole and shaken hard; the two cats dropped—or the attendants think they did.

There was a flash—an explosion, a shower of plate glass and cats; people from the office rushed in to find the place strewn with dead cats, the black Tom included, and the three executioners stretched out on the floor. Two were sent to the hospital, one with a possibly fractured skull, and all were more or less burned and lacerated. The explosion had blown open the steel emptying door and wrecked the plate-glass covers. The ceiling of the room was torn open for several feet and showed where the cats had been blown against it. All are positive that there were no lights burning in the room and that no one was smoking, it being strictly prohibited in the building.

Extinguishing Generator Fires with CO_2.

By T. H. Soren.

Vice-President Hartford Electric Light Company.

Carbon dioxide promises marked success as a means of stifling turbo-generator fires, according to recent tests made at the South Meadow station of the Hartford (Conn.) Electric Light Company. The carbon dioxide is put in a tank at 200 pounds pressure and the connection to the generator is so arranged that the generator can be flooded with the gas both automatically and manually in case of a short circuit. Measurements of the percentage of carbon dioxide retained in the casing at various periods after admission under pressure show that the fire hazard may be regarded as nil if prompt action is taken by the operating force, and that several minutes may be utilized in investigating the causes of apparent difficulties or threatened troubles before it becomes necessary to close the turbine throttle and shut off the water of the air-cooling system. This gives time to transfer the load to other units and insures against interruption of service, which is very important. These results are achieved by relatively simple means—means arrived at, however, after experiments lasting through many months.

The South Meadow station has one 20,000-kw. General Electric generator installed at present, the foundations being prepared for a second unit of the same size. When the plant was designed the General Electric Company recommended the installation of the inclosed system of air cooling, and as experience elsewhere and local conditions were favorable, this was done. Fig. 1 is a diagram of the ventilation system, showing the arrangement of apparatus for admitting carbon dioxide to the generator casing in emergencies, a general view of the equipment being shown in Fig. 3. The air is taken into the generator at each end and discharged through the center. The air, therefore, comes down between two partitions and up through the air washer and eliminators. Later developments of air tight cooling systems use radiators instead of water spray. This is of material advantage as carbon dioxide could be used successfully in much smaller quantity and with lower rate of discharge. With the radiator form of cooling, the air chamber is very much reduced and it would be easier to make it gas tight.

For generator fire protection the manufacturers recommended and furnished with the generator a sprinkler system around the end connections for the use of either steam or water. This seemed undesirable, and, owing to the fact that the inclosed system proved satisfactory and reliable, it seemed best to control generator fires by an inert gas in place of steam or water. The latter system was therefore installed.

Courtesy of *Electrical World*.

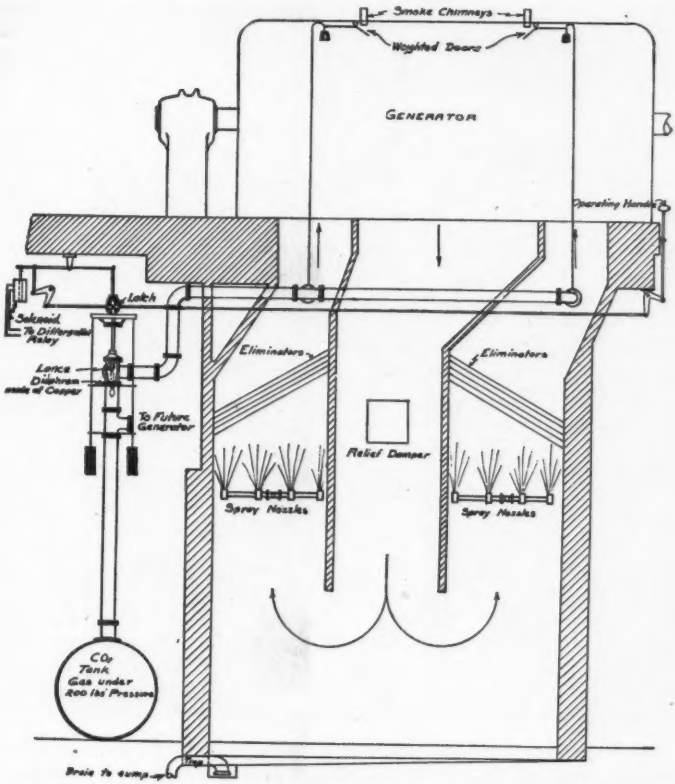

Fig. 1—CO_2 is instantly admitted to generator casing when diaphragm valve is punctured.

The apparatus centers in a tank at the condenser floor level, about 3½ ft. in diameter by 16 ft. long, filled with gas at 200 lb. pressure. This gives approximately 2,000 cu. ft. of gas at atmospheric pressure. The whole inclosed system has a content of about 3,300 cu. ft. of air, which is recirculated at the rate of 55,000 cu. ft. per minute. Therefore the maximum possible proportion of gas is about 40 per cent. From this tank is taken a vertical riser, at the top of which is a tee, with a device, shown in Fig. 2 and described below, for releasing the gas. The pipe then runs along the generator foundations, where the gas is discharged through a 3-in. pipe and a 1-in. nozzle directly under the air intake at each end of the generator. In order to detect fire in the generator, a 3-in. pipe has been inserted through the casing of the air chamber at each end of the armature winding. Weighted dampers have been placed under these pipes, which

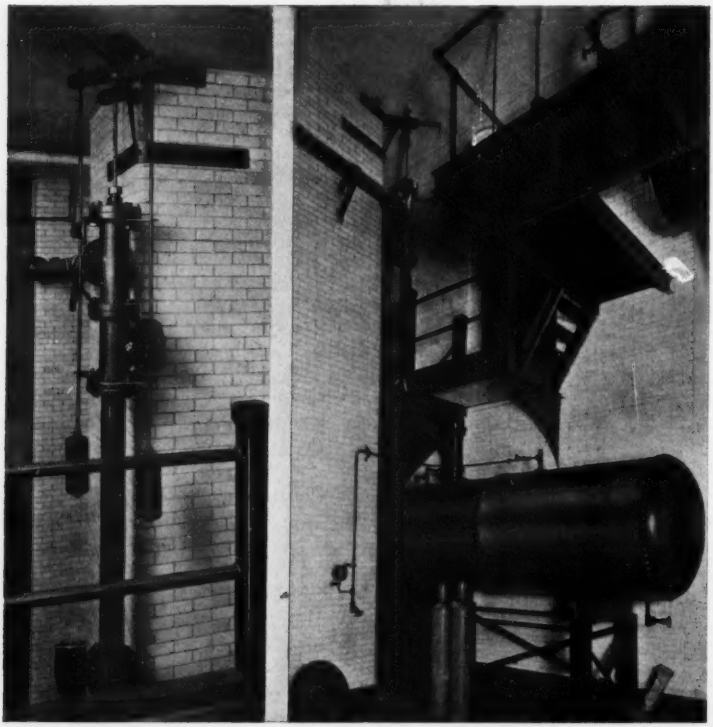

Fig. 2 (at left)—Copper diaphragm in upper section of piping pierced by weighted lance to release CO_2. Fig. 3 (at right)—CC_2 tank and piping occupy little useful space.

are held open by a cable running back to the device for releasing the gas. When the gas is released, these dampers close automatically. The water from the spray nozzles is drawn off at the bottom through a trap. This was found necessary because considerable gas was entrained with the water running to waste.

As the generator lagging is reasonably tight, no change was made from the manufacturer's standard design. The openings in the foundation walls originally intended for the change from open to closed system were closed up with steel doors clamped tightly in place. In one of these doors there is a weighted damper for relieving the pressure when the gas is released from the tank.

The first essential is prompt release of the gas in case of suspected fire, but it is not expected that the gas will have to be released frequently. As a valve is liable to leak and require considerable time for opening and closing, the following arrangement has been substituted:

Under the tee in the riser from the tank there is a thin copper dia-

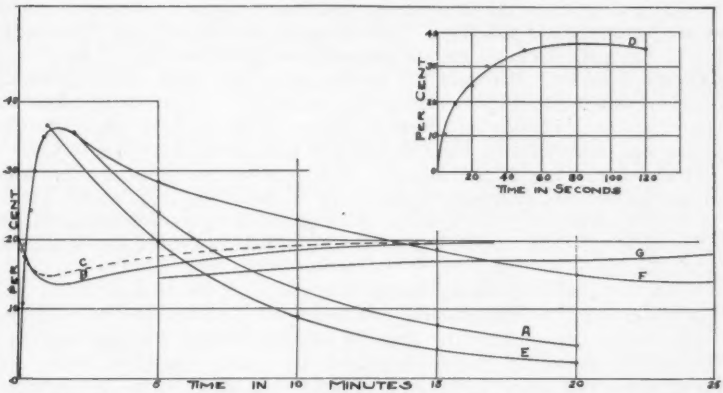

Fig. 4—Concentration and duration of CO_2 obtained in generator ventilating system.

The results of the carbon dioxide tests at Hartford are shown in the above diagram. Research laboratory tests show that air diluted with 10 per cent inert gas will not support combustion. In the diagram, curve *A* shows the percentage of carbon dioxide with the generator operating at full speed with cooling water shut off. The non-combustion percentage was not diminished for about twelve and a half minutes after gas admission.

Curve *B* shows the percentage of oxygen corresponding to curve *A*. Curve *C* shows the percentage of oxygen at various periods when using nitrogen instead of carbon dioxide, the generator being run at full speed and the cooling water supplied at full head. In curve *D* the percentage of carbon dioxide measured during the first two minutes is shown, the maximum being about 37 per cent, attained in about eighty seconds. It will be noted that the non-combustion percentage of 10 per cent was attained in about four seconds after the puncturing of the diaphragm valve.

Curve *E* shows the percentage of carbon dioxide measured with the generator at full speed and with cooling water running at full load. Curve *F* shows the percentage of carbon dioxide with the generator and cooling water shut off about the same time the carbon dioxide was released. Curve *G* shows the oxygen corresponding to curve *F*.

phragm and above it a spearhead. This spearhead is weighted and when released passes completely through the copper diaphragm. In case of suspected fire the spearhead is released from an operating handle on the turbine floor immediately adjacent to the turbine.

The generator is protected by differential relays between the neutral and the generator switch. In case of internal short circuit these relays trip the generator switch automatically. At the same time that the relays operate on the generator switch they also release the spearhead, so that the air chamber is immediately flooded with carbon dioxide.

The object of the scheme is to release the gas immediately on suspicion of fire, giving the operator time to investigate the condition of the machine without interrupting service. With water or steam it would be necessary to take the load off the generator and open the field. With the scheme described it is only necessary to release the gas. Curve *D* in Fig. 4 shows the rate of discharge of the gas in the first two minutes.

Through the courtesy of the General Electric Company, tests were made in its research laboratory which indicate that air diluted with 10 per cent inert gas will not support combustion. Therefore the first rush of gas into the system should snuff out any flame and prevent its breaking out again while there is not less than 10 per cent gas.

Tests were made under different conditions, but none were made with the fire inside the air chamber. This naturally would decrease the amount of free oxygen. Several tests were made without turning off the water in the air chamber. All tests for percentage of gas were made by taking samples from the discharge side of the generator. The gas is taken off in gas bags and tested in an Orsat apparatus, a check being made by testing for oxygen. Carbon dioxide gas was used in all tests but one, as it was the cheapest and most available. The cost per charge was $25. One test was made with nitrogen, as shown in curve *C* (Fig. 4). The cost of a charge of nitrogen is about $50. Nitrogen is not so easily obtained, requires more tanks to charge the main tank and is not quite as efficient as carbon dioxide.

The test condition shown in either curve *A* or curve *E* (Fig. 4) will allow the operator several minutes to investigate conditions before shutting off the water and closing the throttle on the turbine, and still retain a sufficient percentage of carbon dioxide to prevent spread of fire. In case of a serious short circuit the generator field is opened and the gas released automatically. The operator then trips the throttle valve and shuts off the water. Curves *F* and *G* show carbon dioxide and oxygen curves under this condition from tests.

After the machine came to rest, in about twenty minutes, the proportion of carbon dioxide remained for some time practically constant at above 13 per cent. It would therefore appear that the system as installed can be counted on to prevent the spread of fire from one set of coils to the next set under the worst possible conditions.

The system as laid out is intended to take care of more than one generator. With additional generators it might be advisable to install a second smaller tank with gas between 300 lb. and 400 lb. pressure that could be released into the larger tank and so continue to feed carbon dioxide to the system or, in case of a second fire, into the second generator.

The process of charging the large tank from the high-pressure tanks as purchased is a long one, requiring two or three hours. The tanks purchased contain liquid carbon dioxide, and to release this into the main tank requires a water jacket heated by a steam jet.

The writer is indebted to A. R. Smith of the General Electric Company, Schenectady, N. Y., for his assistance in working out many of the problems of this system.

The Shelton Hall Fire, Pittsburgh.

During the evening of March 7, 1923, a fire occurred at Shelton Hall, 522 Federal Street, North Side, Pittsburgh, which cost the lives of three persons and seriously injured thirty-five. The fact that there was only one narrow open stairway for the use of occupants of the upper floors of the building and that this was cut off at the start of the fire by its rapid spread to all floors through an open elevator shaft was responsible for the loss of life and injury.

The building was an L shaped structure fronting on Federal Street, extending around back of the Dollar Savings and Trust Co. building and facing on East South Diamond Street. It was an old building of ordinary brick, joisted construction and had been remodeled several times. The section facing on Federal Street was four stories and the section facing on East South Diamond Street was three stories. A few years ago the first floor of the building on the Federal Street side was occupied as a retail shoe store. The original front stairway of the building was taken out to add width to the store. The only stairway for use of occupants on upper floors was then a three foot open stairway which went only from the ground floor to the second floor. This stairway did not connect directly with the stairways to upper floors and on the third and fourth floors it was necessary to walk along a corridor the full width of the building before gaining access to the stairways to floors below.

In the corner of the building where the two sections were joined there was an abandoned elevator shaft which acted as a flue to spread the fire through the entire building.

The building had no fire escapes. There were no automatic sprinklers, fire extinguishers, or other interior protection.

Occupancy.

The Federal Street first floor and basement was occupied by the retail shoe store. The East South Diamond Street side was occupied in the basement as a barber shop, and the first floor as a shoe repairing shop. The second and third floors were used for various lodge purposes and two spiritualist churches had rooms. The fourth floor, fronting on Federal Street, was occupied by the caretaker who acted as a janitor for the lodge rooms and church rooms.

Story of the Fire.

The fire originated in the shoe store near the open elevator shaft. There was a flash of fire, followed shortly after by an explosion. While the exact cause of the fire has not been established, the evidence points to incendiarism. Somewhat earlier in the evening two men were seen to

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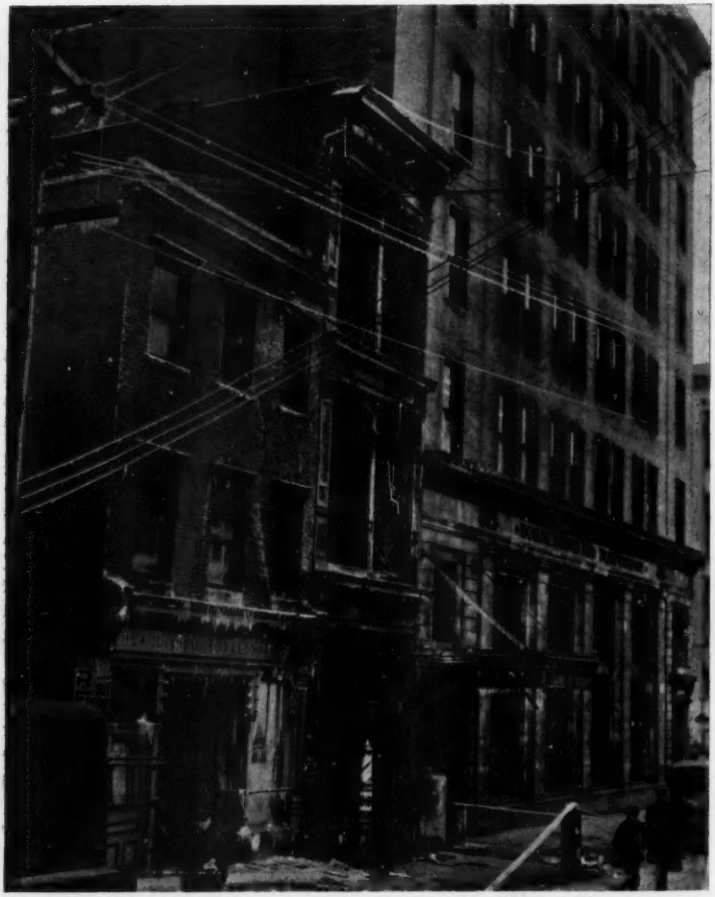
The data on this fire was obtained through the courtesy of Chief Fire Marshal Thomas L. Pfarr of Allegheny County.



The narrow entrance to the Shelton Hall Building is shown in the center. This one stairway was the only means of exit from the building which extended around back of the building on the right and faced on another street.

leave the building hurriedly. The very rapid spread of the fire would indicate the use of gasoline.

An alarm was turned in by an outsider who saw the flash. Apparatus from a central fire station within two blocks of the building responded promptly. Owing to the narrowness of the street and to the fact that the street railway company had erected waiting platforms on each side of the street which only permit of an ordinary vehicle passing between them and the curb, the hook and ladder company had difficulty in getting the truck into the narrow space. Further trouble was caused by electric signs over the sidewalk. The chains and braces from these signs hindered

the raising of ladders and also offered obstruction to occupants of the building who had to jump out of the windows into nets.

At the time of the fire the Stone Masons' Union were having a meeting on the third floor with about twenty in attendance. One of these men jumped out of the window with the intention of landing on the roof of an adjoining two-story building. He landed on a skylight, fell through this, and was killed. In a room on the third floor of the building a spiritualist church meeting was in progress, sixteen or eighteen people being in attendance. All of these had to jump into nets or be carried down ladders. Thirteen of them were injured, one so seriously that she later died. There was another spiritualist church meeting in progress with twenty-eight persons in attendance. All of these had to jump into nets and twenty of them had to be removed to the hospital. One of these died in the hospital.

The building was quite badly damaged before the fire was controlled.

Oil Refining and Storage—Fire Record.

The fire record files of the National Fire Protection Association include 215 fires in oil refineries and oil tanks which have occurred during the period 1897-1922 inclusive. It will be recognized that these reported fires are but a small fraction of the fires in the oil industry during this period. Authentic reports on oil fires have been difficult to obtain. Many of the oil fires occur in sparsely settled districts and are not reported through the usual channels. It is felt, however, that the data afforded by these comparatively few recorded fires is of sufficient general interest to warrant a brief summary.

Lightning is the chief cause of oil refinery and tank fires. The isolated large oil tank in flat country makes an excellent target for lightning and as the protection of such tanks is usually deficient the resulting losses are large. Of fifteen fires in oil tanks caused by lightning where exact loss figures are given, the loss averages $135,000.

Sparks from boilers is the next most prominent common cause, but is far below lightning. Leaks of oil due to defects or breaks in apparatus is the chief special hazard cause. It would seem that this cause is strictly preventable, and shows a lack of proper inspection. Overheating and boiling over of still is also a strictly preventable cause. Carelessness is prevalent even in the oil industry where the fire danger should be fully recognized.

It is not surprising that 57 per cent of the fires cause losses of over $5,000. An oil fire is usually a bad fire. The actual loss figures are given in 115 fires. These fires show an average loss of $88,000. Forty-one of these fires caused loss less than $5,000, 28 caused loss between $5,000 and $25,000, 18 caused loss between $25,000 and $50,000, and 28 caused loss of over $50,000.

Oil Refining and Storage – Fire Record.

Total Number of Fires Reported 215.

CLASSIFICATION OF CAUSES.

Common Causes.

	No. of Fires	Per Cent of Known Causes
Lightning	40	23.4
Boiler Sparks	12	7.0
Defective Electric Wiring	7	4.1
Exposure	6	3.5
Matches	5	2.9
Spontaneous Ignition	5	2.9
Incendiary	4	2.3
Power	3	1.8
Open Lights	3	1.8
	85	

Special Hazard Causes.

	No. of Fires	Per Cent of Known Causes
Leaks of oil due to defects or breaks in apparatus	25	14.6
Ignition of fumes by sparks (exact cause unknown in most cases)	18	10.5
Explosion (exact cause unknown)	18	10.5
Overheating and boiling over of stills	11	6.4
Ignition of fumes by boiler	2	1.2
Ignition of fumes by grass fire	2	1.2
Ignition of fumes by automobile backfire	2	1.2
Miscellaneous	8	4.7
Total	86	

	No. of Fires	Per Cent of Total
Common Causes	85	39.5
Special Hazard Causes	86	40.0
Total Known Causes	171	79.5
Unknown Causes	44	20.5
Total	215	100.0

Analysis of Loss.*

	No. of Fires	Per Cent
Large Loss	124	57.7
Small Loss	61	28.4
No Data	30	13.9
Total	215	100.0

* Large loss fires are those causing damage of more than $5,000.

Some Oil Fires Which Caused Loss of Life.

H-11237. PHILADELPHIA, PA., OCTOBER 6, 1915. The fire occurred when a pipe on an oil still broke allowing the oil to come in contact with a fire in a furnace nearby. The clothes of the still operator became saturated with oil and ignited. The man was burned to death. The fire was extinguished by employees with small property loss.

H-14515. MARRERO, LA., AUGUST 19, 1918. Six men were working inside of a riveted sheet steel tank, cleaning the inside of the tank preparatory to using the tank for storage of gasoline. They were on a scaffold about 10 feet high. The work being nearly completed, the foreman desired to have water pumped in the tank in order to float out the scaffold timbers through a manhole in the side. A 4-inch pipe was connected near the bottom of the tank, and after extending some distance entered a "T" fitting; thus branching into two pipes each of which is provided with a valve. One of the branches connected with the suction of the gasoline pump in the pump house, while the other connected with the discharge line from the gasoline pump. The pump house attendant, having been instructed to pump water through this pipe, started up with the water pump, and called upon the gauger, whose duty it is to attend to the valves, to open the valve in the water discharge line. The gauger, not being familiar with the valves for the new tank, opened the valve in the branch line connected with the gasoline discharge system. This allowed gasoline to flow into the tank where the men were working. It was soon discovered that the wrong valve had been opened, and the pump attendant and gauger closed this valve and opened the valve which was connected to the water pump and began pumping water into the new tank. In the meantime, however, a large quantity of gasoline had entered the new tank. One of the workmen lit a match and the fumes exploded, killing all six men. The damage by fire was negligible.

H-15932. COTTONWOOD, MINN., NOVEMBER 10, 1919. An employee went to the oil storage plant early in the morning to fill a kerosene supply tank. He did not watch the tank carefully and the kerosene overflowed from the tank. Some of the kerosene reached an electric motor and ignited. A flash fire ensued, the man's clothing caught fire and he was burned to death. The building was destroyed.

H-16090. HAYS, KANSAS, NOVEMBER 17, 1919. The fire started between seven and eight in the morning when an employee of the oil company attempted to crank a truck which had been stored in the supply house of the oil storage plant. The engine backfired and the room was enveloped in flames. The flames spread to large storage tanks, the contents of two burning without causing explosions but the third exploded with great force. Parts of this tank were blown 462 feet. A crowd had collected to watch the spectacular blaze and when the tank exploded ten were killed and twenty-six severely injured. A grain elevator on adjoining property was burned. The total property loss was $100,000.

H-16058. WEBSTER, TEXAS, JANUARY 17, 1920. The fire occurred in a tank containing very volatile high grade oil. There were two employees calking a seam on the tank and a third was ascending a ladder to

gauge the oil. A spark from a hammer striking the chisel which one of the men was using in calking the tank ignited the fumes and an explosion occurred. The man on the ladder was hurled through the air and instantly killed. There was no fire protection for the tank and the fire was allowed to burn itself out. The loss was $80,000.

H-16749. WEST BEND, WIS., SEPTEMBER 11, 1920. Some boys were trying to steal some gasoline from a large storage tank for use in their motorcycle. One of them lit a match to see if the can was full and the tank exploded. One boy was burned to death and two others badly injured. The property loss was $3,500.

H-17559. SALT LAKE CITY, JUNE 11, 1921. During a heavy thunder storm lightning struck a tank containing gasoline. The fire spread rapidly and nine large tanks became involved. One of these tanks was weakened by the heat and burst, killing three men and injuring several others. The fire burned for twenty-two hours causing property damage of about $250,000.

H-17813. PHILADELPHIA, PA., AUGUST 14, 1921. An explosion of a steam operated still scattered blazing oil and ignited the clothing of twenty-five workmen who were nearby. Five of these men were burned to death and twelve others seriously injured. The fire spread to four agitators which contained several thousand barrels of oil and thence to five large oil tanks. The plant was partially destroyed, the loss being about $1,000,000.

H-17813-A. PHILADELPHIA, PA., SEPTEMBER 14, 1921. Ten men were killed and several others seriously injured in an explosion of unknown cause which occurred in the section of the plant where naphtha was being distilled. The workmen were drenched with blazing oil before they could reach safety. Dense smoke and intense heat made rescue work extremely difficult. The fire was extinguished without serious property damage.

H-18573. EVERETT, MASS., APRIL 14, 1922. An explosion of gasoline vapor occurred underneath the air compressor room, killing one man and injuring several others. The area under the building was filled in with cinders over the gasoline, kerosene and oil pipes, but the filling sank away, leaving a pit in which oil and vapors accumulated. It is believed that an electric spark either from broken wiring or from static accumulation caused the igniting. The explosion raised the concrete floor about six inches, cracking four of the reinforced concrete beams at one end of the building. The fire was confined to the pit and extinguished with small loss.

Two Fires in Concrete Buildings Under Construction.

Within three days of each other last January two large concrete warehouses under construction in widely separated places were subjected to serious fire damage. On January 4, 1923, the McDougall Terminal Warehouse at Duluth was partially destroyed and on January 7, 1923, the James Butler grocery warehouse at Long Island City was similarly damaged. The necessity of adequate fire protection in buildings of this type is clearly illustrated by the reports which follow.

The Duluth Terminal Warehouse Fire.*

The building which was under construction was 488 feet in length, 130 feet in width, and was five stories high on the South end, four stories in the center and North end at the time of the fire. It was located on the Bay front at the foot of Ninth Avenue West, Duluth, Minn. A detached reinforced concrete power house was located ten feet east. The type of construction used is known as the "flat slab system." The floor slabs are nine and ten inches thick, roofs six inches, reinforced by three-eighths and one-half inch steel rods. The columns are twenty-two to thirty inches in diameter, reinforced with four to eight three-quarter and one-inch upright steel rods with three-eighths inch spiral reinforcement. The mixture used in the slabs is one part cement, two parts of coarse lake sand and four parts gravel, and that in the columns is one part cement, two parts coarse lake sand and three parts lake gravel. Part of the North end of the building was supported by built-up steel girders, one member parallel with the street about fifty feet by four feet and the other member parallel with the side of the North end of the building about thirty by four feet.

The first floor was completed during October, the second and third floors during November, and the fourth and fifth during December, with the exception of the North end of the fourth floor, which was completed only the day before the fire.

The floor form boards and props had been removed from the first and second floors but were in at the time of the fire on the third, fourth and fifth floors. The floor forms were made of seven-eighths inch lumber, surfaced on one side and two edges. The props were four by four rough lumber, set four feet on centers throughout the third, fourth and fifth floors, there being about one million feet of lumber in all in the building. The number and close proximity of the props is clearly shown in the photograph. The fourth and fifth floors were covered with three inches of shavings and these floors were heated with salamanders burning hard coal, coke being unobtainable. The third, fourth and fifth floors were

* Reported by R. M. Ritchie (Member N. F. P. A.), Secretary and Manager of The Insurance Service Agency, Inc.

The fire in the McDougall Terminal Warehouse at Duluth. The concrete building under construction contained a large amount of wooden forms which made excellent fuel as shown above.

enclosed with heavy canvas curtains. There were no division walls and with the exception of the curtains enclosing certain floors, the building was entirely open.

There is a twelve-inch city main in the street directly in front of the property, with three hydrants within 300 feet. The bay and slip, under ordinary circumstances, would furnish a water supply, but at the time of the fire were frozen over and it is doubtful whether additional water supply would have been of any value by reason of the rapid ignition of the combustible material.

Story of the Fire.

On the fourth of January, 1923, the temperature was about thirty degrees above zero and there was a Northwest wind of about ten to twelve miles an hour. The men quit work at five o'clock P. M. and at the time of the discovery of the fire there were only three men in the building, one of the contractors among them. The fire was discovered about 5:15 P. M. at the North end of the third floor in the canvas curtains and presumably originated from one of the salamanders, although that has not been definitely established. An alarm was immediately turned in but the fire spread so rapidly that within fifteen minutes the entire fourth and fifth floors were ablaze. In fact, it spread so rapidly that the three men in the building at the time of the fire had difficulty in getting out. The fire burned rapidly and fiercely for some twenty minutes and continued for about one and a half hours before it was under control. Notwithstanding the fact that the building was accessible on all sides, the fire department had little chance to be of value except to save exterior frame work, frame tower and cranes.

The rapid spread of the fire is accounted for by the combination of shavings, props and form boards, and gas, from burning hard coal in salamanders, accumulating at the ceilings throughout the entire building.

As the props burned and fell, the ends of the floor forms dropped down allowing the fire to get in between the floor forms and the concrete, causing complete destruction of the lumber and heavy damage to the concrete slabs.

The outer coverings on all columns, that is, the fireproofing outside of the spiral steel enclosing the cores, on the fourth and fifth floors and part of the third floor, was cracked and disintegrated and the cores themselves damaged beyond repair in a number of cases. The fourth and fifth floor slabs badly chipped and cracked on the under surface, which makes necessary replacement of a large part of the same, and the outside columns on the West side of the third and fourth and fifth floors badly chipped and cracked. The fourth floor at the North end of the building was finished the day before the fire and completely collapsed. Several of the plates in the steel members buckled and it will undoubtedly be necessary to replace them, although it is believed that the carrying capacity of the members has not been impaired.

That part of the concrete damaged beyond repair is being removed by cutting with chisels and hammers and using acetylene torches on the steel rods.

The contractors as yet have no figures on the cost of removing the damaged concrete. The cost of constructing new concrete in this building ran from forty to fifty cents a square foot.

The fire in the McDougall Terminal Warehouse at Duluth. The concrete building under construction contained a large amount of wooden forms which made excellent fuel as shown above.

The value of the building at the time of the fire, exclusive of piling, was about $600,000. The total loss is figured at from $175,000 to $200,000.

The results of this fire present one of the best object lessons that has occurred in many years on the amount of damage possible to a concrete building under construction.

The James Butler Grocery Warehouse Fire.*

The building was a six-story reinforced concrete warehouse, under construction at the time of the fire. The arches were made of reinforced concrete of the type known as "mushroom" construction. All the concrete arches on the first and second floors had been poured with the exception of 25 per cent of the second floor at the southwest corner. The forms for the unfinished part were not up but the forms for about 10 per cent of the third floor were in place near the northeast corner. None of the concrete arches on the third floor had been poured.

There were thirty open, coke fuel, furnaces used as salamanders to prevent fresh concrete from freezing before setting.

The fire originated in a canvas curtain on the first floor at the northwest section of the building, either from a flying spark or from contact with a salamander. A space 100 by 120 ft. at the northerly end was curtained off by canvas and the thirty salamanders were in use here to dry the freshly poured concrete floor arches of the second floor.

The fire was discovered by a watchman of the building who had shortly before placed fresh coke on the salamanders. He attempted to extinguish the burning canvas while another watchman blew his whistle to attract attention. At about the same time, a watchman across the street, seeing the fire, telephoned an alarm to the fire department at 4:47 A. M. On the arrival of the department, second and third alarms were sent in.

All of the canvas curtains on the first floor were ignited and these in turn set fire to the wooden forms for second and third floor concrete arches. All of these forms were either completely burned or badly damaged. Five half panels of "green" concrete floor arches collapsed. The concrete columns and the steel plate girder protection were badly spalled.

Conclusions.

This experience illustrates the importance of the fire hazard involved during the construction of concrete buildings, due to:

FIRST: The large amount of lumber for construction of the wooden forms for the floor arches, columns and walls.

SECOND: The high fire hazard resulting from the use of numerous salamanders or similar furnaces for heating large areas in order to make it possible to pour the concrete during freezing weather. The canvas curtains for enclosing the heated area act as effective kindling material to bring about the ignition of the lumber contained in the wooden forms.

* Report by the New York Board of Fire Underwriters (Member N. F. P. A.)

Furniture Factories—Fire Record.

The tables presented herewith include 1192 furniture factory fires which have been reported during the years 1897-1922 inclusive. This classification completes the data on woodworking industries (see Sawmills — Fire Record, October 1922 QUARTERLY, and Woodworkers — Fire Record, January 1923 QUARTERLY).

The causes of fire in furniture factories are many and varied. It takes very little to start a fire in a building filled with wood, paint and varnish, upholstery, excelsior, etc. Common causes are responsible for most of the fires. Fires in the boiler room or from sparks from the boiler stack are the most common. The proper isolation and protection of the boiler house and the use of spark arresters are essential to an industry where so much inflammable material is present.

Oily material is the second chief cause of fires. While this cause has been placed among the list of common causes, it might well have been placed with the special hazard causes in the finishing processes as it is for finishing that oily material is used in considerable quantity. The use of safe containers for oils and varnishes is very important. A good system of prompt disposal of oily waste is also a necessity.

As in the woodworking plants the most prevalent special hazard causes of fire are those involving the dry kiln and the shavings vault. These two danger spots seldom receive the proper protection and inspection that their hazard calls for. The manufacture of upholstery for the furniture introduces the picker hazard. Fires due to foreign matter in the picker are comparatively common.

The finishing and polishing processes involve the use of inflammable liquids and the dip tank hazard. Finishing room fires are usually severe and involve large damage. Special precautions for the proper handling and storage of inflammable liquids should be taken.

The sprinkler record shows that approximately 93 per cent of the fires in sprinklered factories were checked by the operation of the sprinklers. This compares with the general average efficiency of 95.7 per cent for all occupancies and is a very satisfactory showing considering the severe hazard of the industry. The wet system is much more common than the dry system. The necessity for prompt operation makes the use of the dry system undesirable where it can be avoided. The average number of sprinklers opened is 15, indicating the severity of fires in this industry.

The value of sprinkler protection is strikingly shown in the loss figures. Of the small loss fires 87.7 per cent were in sprinklered factories while 62.7 per cent of the large loss fires were in unsprinklered factories.

Furniture Factories—Fire Record

Total Number of Fires Reported 1192.

CLASSIFICATION OF CAUSES.

Common Causes.

	No. of Fires	Per Cent of Common Causes	Per Cent of Total Known Causes
Boiler or Fuel	150	22.4	16.6
Oily Material	144	21.5	15.9
Power	79	11.8	8.7
Smoking—Matches	59	8.8	6.5
Lighting	40	6.0	4.4
Exposure	35	5.2	3.9
Rubbish or Sweepings	30	4.4	3.3
Heating	30	4.4	3.3
Incendiary	23	3.4	2.5
Chimney or Flue	22	3.3	2.4
Sparks from Locomotive	19	2.8	2.1
Lightning	18	2.7	2.0
Spontaneous Ignition	16	2.4	1.8
Miscellaneous	6	.9	.7
Total	671	100.0	74.1

Special Hazard Causes.

WOODWORKING PROCESSES.

	No. of Fires	Per Cent of Special Causes	Per Cent of Total Known Causes.
Dry Kiln (exact cause unknown)	46	19.6	5.1
Shavings Vault	41	17.5	4.5
Sawdust	9	3.8	1.0
Band Saw	6	2.5	.7
Dust Explosion	2	.85	.2
Total	104	44.25	11.5

FINISHING PROCESSES.

Inflammable Liquids	17	7.2	1.9
Dip Tank	16	6.8	1.8
Varnishing	9	3.8	1.0
Sanding Machine	6	2.5	.7
Embossing Machine	4	1.7	.4
Spray Booth	4	1.7	.4
Enamelling Oven	3	1.3	.3
Wax Melting	3	1.3	.3
Buffing	2	.85	.2
Total	64	27.15	7.0

Miscellaneous Processes.

	No. of Fires	Per Cent of Special Causes	Per Cent of Total Known Causes
Picker	22	9.4	2.4
Blower System	14	6.0	1.6
Conveyor	5	2.1	.6
Forge or Furnace	4	1.7	.4
Glue Heating	3	1.3	.3
Static Electricity	2	.85	.2
Excelsior Machine	2	.85	.2
Miscellaneous	15	6.4	1.7
Total	67	28.6	7.4
Total Special Hazard	235	100.0	25.9

	No. of Fires	Per Cent of Total
Common Causes	671	56.4
Special Hazard Causes	235	19.7
Total Known Causes	906	76.1
Unknown Cause	286	23.9
Total	1192	100.0

Sprinkler Fire Record.

	No. of Fires	Per Cent
Extinguished Fire	501	65.6
Held Fire in Check	208	27.3
Total Satisfactory	709	92.9
Unsatisfactory	54	7.1
Total	763	100.0

There were 117 fires in which no sprinklers opened.

Comparison of Wet and Dry Systems.

	Ext. Fire	Per Cent	Held in Check	Per Cent	Unsatisfactory	Per Cent	Total	Per Cent
Wet System	342	68.3	133	63.9	32	59.3	507	66.5
Dry System	159	31.7	75	36.1	22	40.7	256	33.5
Total	501	100.0	208	100.0	54	100.0	763	100.0

Number of Sprinklers Opened (Average 15).

No. of Sprinklers Operating	No. of Fires	Per Cent
1	259	34.3
2	118	15.6
3	90	11.9
4	55	7.3
5	30	4.0
6-9 inclusive	58	7.6
10-25 inclusive	71	9.4
26-50 inclusive	24	3.2
51-100 inclusive	20	2.7
101-200 inclusive	19	2.5
201-300 inclusive	6	.8
Over 300	5	.7
	755	100.0
All Heads Opened (no data as to number)	12	
No Heads Opened	117	
No Data	5	
Total	889	

Miscellaneous Statistics.

Analysis of Loss.*

	Small Loss	Per Cent	Large Loss	Per Cent	No Data	Per Cent	Total	Per Cent
Sprinklered	778	87.7	102	37.3	9	29.0	889	74.5
Unsprinklered	109	12.3	172	62.7	22	71.0	303	25.5
Total Fires	887	100.0	274	100.0	31	100.0	1192	100.0

	No. of Fires	Per Cent
Small Loss	887	74.4
Large Loss	274	23.0
No Data	31	2.6
Total	1192	100.0

*Large loss fires are fires causing damage greater than $5,000.

Day or Night Fires (Day Fires 6 A. M. to 6 P. M.)

	No. of Fires	Per Cent
Day Fires	572	48.0
Night Fires	584	48.9
No Data	36	3.1
Total	1192	100.0

HOW DISCOVERED.

	No. of Fires	Per Cent
Employee	451	37.8
Watchman	299	25.1
Outsider	210	17.6
Sprinkler Alarm	156	13.1
Supervisory System	18	1.5
Thermostat	15	1.3
No Data	43	3.6
Total	1192	100.0

ROOM IN WHICH FIRE OCCURRED.

	No. of Fires	Per Cent
Boiler or Engine	185	15.5
Finishing	181	15.2
Storage	103	8.6
Dry Kiln	81	6.8
Woodworking	72	6.0
Shavings Vault	65	5.4
Basement	46	3.9
Packing and Shipping	25	2.1
Picker	25	2.1
Roof	24	2.0
Upholstering	19	1.6
Main Building	19	1.6
Outside	15	1.3
Cabinet Working	12	1.0
Oil Room	10	.8
Office	8	.7
Waste Chute	4	.3
Dust Collector	3	.3
Elevator Shaft	3	.3
Miscellaneous	38	3.2
No Data	254	21.3
Total	1192	100.0

Some Interesting Fires in Furniture Factories.

Boiler.

H-18589. The plant was an old frame structure with a brick boiler house not cut off. The fire started at 9:25 P. M. in the boiler room in some shavings on the floor in front of the boiler while the night man was in the engine room. The fire quickly spread to the main factory through unprotected wall openings. Two employees who entered the building during the fire were burned to death, and several others barely escaped by sliding down a guy wire. The buildings were entirely destroyed.

Power.

S-26486. An employee using spraying apparatus had been operating the spray for some time without the exhaust fan being in operation, thus causing a large accumulation of gas in the booth. When the exhaust fan was started, a spark from the motor ignited the gas and the ensuing fire ignited a large stock of freshly varnished tables. All of the sprinklers in the room, 148 in number, opened. The sprinklers checked the fire but it was necessary to use hose streams to finally extinguish it. The roof and its supports were badly charred. The wired glass in one of the skylights melted from the intense heat. The fire was confined to the second floor. It caused a loss of about $25,000.

Matches—Smoking.

S-22357. The fire started on the first floor of an unsprinklered wooden warehouse, presumably due to a cigarette butt dropped in a pile of excelsior pads. The fire spread rapidly through the entire building which contained cotton padding, 2,500 bodies of baby carriages, wheels and various parts. This building, which was of inferior construction with extensive floor openings, was cut off from the manufacturing building by a 12-inch fire wall with swinging fire doors at each floor. The fire was held at this wall although the doors on upper floors were nearly burned through. Sprinklers which opened near this wall materially assisted in holding the fire in check. The storehouse was practically a total loss and the stock which was not consumed was soaked with water and frozen into a solid mass.

S-29387. An employee (about 21 years old) was amusing himself and others by spattering alcohol thinned shellac from a small brush on lighted matches which he held in his hand. The brush ignited and he plunged it into a pail of benzine which he thought was water. This flashed and painfully burned the man. The pail was tipped over and a considerable blaze resulted, which ignited a bench and other nearby material. The fire was extinguished by sprinklers and chemical extinguishers.

Rubbish.

H-16089. The plant was a three-story brick structure occupied for cabinet making. The fire is believed to have been caused by a bunch of waste or a lighted match thrown into the fly wheel pit in the engine room, where a lot of rubbish had accumulated. The engineer threw a bucket of water on the fire but this had no effect, so he gave the alarm to the employees on the upper floors. The fire and smoke spread rapidly throughout the building and caused a stampede among the employees, and as there was no outside fire escape, some of the men escaped from the windows by jumping on to the roofs of other buildings below. Of the 36 men in the building, 6 were caught and were suffocated or burned to death. The entire building with contents, including machinery, was destroyed.

Heating.

H-9768. The plant was a two-story frame structure manufacturing high grade furniture. The fire was caused by the ignition of fine sawdust,

which had been allowed to accumulate between steam heating coils and the walls. The entire second floor was ablaze when the fire was discovered. A heavy gale was blowing flame and embers into a section of frame shingle roofed dwellings so that the fire department abandoned efforts to save the factory and concentrated on the dwellings. All the buildings of the factory were destroyed within an hour. The danger of allowing such a structure in a thickly settled residence district is obvious.

Spontaneous Ignition.

S-32219. Fire was discovered at 2:30 A. M. on the third floor of a three-story brick and joist furniture factory. When firemen arrived the fire was burning upward on a post from the stairway to the roof. The fire was extinguished with small loss. The cause of the fire was spontaneous ignition of an enamel paint which had collected in the hollow space between the floor and the ceiling. The floor was of single boards and had numerous cracks so that paint when spilled drained through to the hollow space. The paint used was known to be subject to spontaneous ignition and had given trouble previously.

Incendiary.

S-26719. The fire occurred in the varnish store room of a brick chair factory. A negro, having a grudge against a white employee, walked into the supply room and deliberately threw a lighted match into a pail of volatile "wax" which the white boy was drawing from a barrel. The clothes of the latter ignited and he ran out of the room into the main varnish room, igniting a dip tank and causing 120 sprinkler heads to open. The room was filled with chairs in the process of dipping and drying and it was two hours before the fire was completely under control. Owing to the action of the sprinklers and the good construction of the building, there was comparatively little fire damage. The negro was slightly burned; the white boy died of burns shortly after. Other employees were able to escape without injury.

Dry Kiln.

S-20178. The fire occurred in some unsprinklered frame dry houses in a plant manufacturing fine furniture. The arrangement of the dry kiln heating system was poor, allowing the accumulation of about four inches of sawdust around the steam pipes. A fan carried air from outside over these pipes delivering the hot air under the lumber piles. The fire started in or around these heater pipes and spread very rapidly. The kilns were completely destroyed but the fire was checked at a sprinklered sawing and lumber storage shed between the kilns and the main building. Twenty-seven sprinkler heads opened.

Shavings Vault.

S-26221. Fire occurred under the roof of the shavings vault due to choking of shavings in a pipe just above the vault. The fire department had to chop open the roof of the shavings vault to get at the flames. The fire was extinguished by chemicals and one hose line. There were two

sprinkler heads in the vault but a valve in the piping was closed and sprinklers did not operate.

Spray Booth.

S-31350. The fire occurred in a spray booth, used for enamel spraying, due to a spark from a fan blade igniting benzine fumes. At the time of the fire the plant was running at night until eight o'clock. The operator of the spraying machine had noticed toward the close of the day that a blade of the fan in the vent from the spray cabinet to the outside of the building was loose. At about 7:45 P. M., operations in the spraying department were stopped as usual, and the operator washed out the hose from the enamel container to the spraying nozzle with benzine in order to keep the hose clear of dried enamel. He then called the foreman to show him the defective fan. As the motor was started a flash fire spread through the cabinet and flames burst out into the room. Sprinkler heads operated immediately, the fire was apparently extinguished and water was turned off the sprinklers. The fire broke out again, however, in an accumulation of paint, varnish, and enamel in and around the spraying cabinet and water had to be again turned on the sprinklers. The water damage was large.

Varnishing.

S-32225. This plant, which manufactured high grade furniture, contained a varnish spray booth. The booth was metal, lined with paper for purposes of cleaning. An electric heater with open wiring and no pilot lamps hung from the edge of the booth. Shortly before shutting down at 6 P. M. there was an interruption in the current, which stopped the ventilating fan and cooled the heater. There were separate snap switches for the fan and the heater. It is assumed that the employee neglected to open one or both of these switches, so that when the current came back on, which was after closing time, either the heating up of the fan motor or the heater ignited the varnish soaked paper lining of the booth. The booth was badly damaged by fire. Sprinklers outside prevented further spread.

Picker.

S-24571. The fire originated due to some foreign material striking a spark in a hair picker in the upholstering department. The fire was blown through a metal pipe to some stock bins on the floor above. One sprinkler opened in the picker room, four sprinklers opened in the stock room, and two in the upholstery room. These held the fire in check until the fire department extinguished the fire with chemicals.

A Disastrous Department Store Fire.

During the evening of March 8, 1923, a fire, causing a loss of well over a million dollars, occurred in a large department store in Providence, R. I. The large loss combined with the fact that the building was completely equipped with automatic sprinklers and readily accessible to the city fire department make the details of this fire of unusual interest.

Construction.

The property involved was a brick building, part six-story and basement and part four-story, occupying all of a block in the center of the retail mercantile section of the city. The ground area is 385 ft. by 120 ft. and the area of the six-story part is 120 ft. by 212 ft. The floors were of joisted construction except the sixth floor which was 2 in. matched plank, with finish flooring, on timber spaced 4 ft. on centers. The finish of the sixth story was open and the remainder was metal or plaster sheathed. The roof of the sixth story part where the fire occurred was light plank on timber, timbers spaced 4 ft. apart. There were open stairways and open elevator shafts. The windows were of wired glass and the building was equipped with open sprinklers as a protection against exposure fires. The roofs were of slow burning construction. There were several small tin clad wood roof houses, all but one sprinklered.

Occupancy.

The occupancy of the building was as follows:

BASEMENT. Heating and power plant, cafeteria, dressing rooms, shipping room, storage.

FIRST FLOOR. Main store, general dry goods.

SECOND FLOOR. Kitchen, restaurant, millinery, cloaks and suits, dry goods.

THIRD FLOOR. Paint and hardware, carpets. pictures, pianos, crockery, household goods.

FOURTH FLOOR. Furniture, wall paper, upholstery, offices.

FIFTH FLOOR. Packing, storage and repair of furniture, cold storage of furs, etc. Stock rooms.

SIXTH FLOOR. Stock rooms, upholstering work.

Protection.

ALARM SERVICE. The store had watchman service with stationary and portable clocks. The alarm for this fire was transmitted by a watchman through a fire alarm box in the store. There was also a sprinkler alarm valve connected to a bell in the building; this operated.

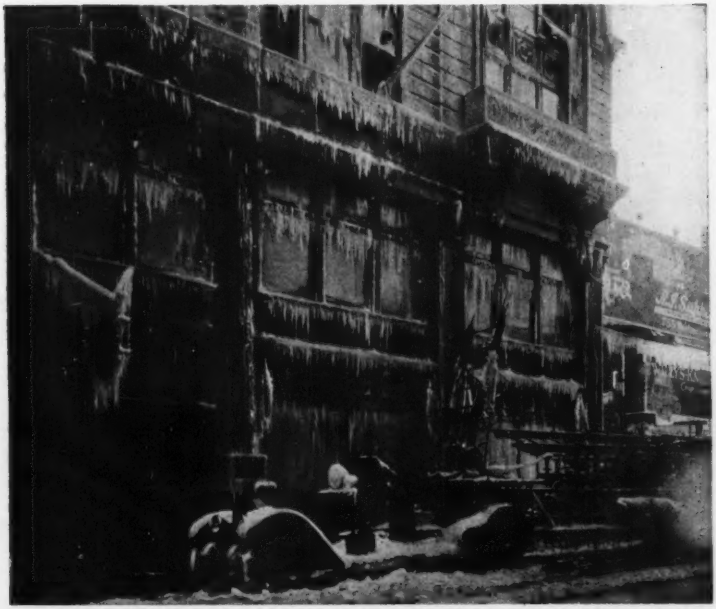
AUTOMATIC SPRINKLERS. The building was provided with a complete wet pipe sprinkler system supplied by one high service (115 lbs.) and two low service (65 lbs.) connections from ample street mains. There were seven principal sprinkler risers with control valves in the basement, there being ten principal control valves in a basement congested and obstructed by numerous partitions, walls, racks, foundations and equipment. There were no floor control valves.

1. The department store on the morning after the fire. The top floor and part of the fifth floor were badly gutted and the contents of the entire building sustained heavy water damage.

FIRE DEPARTMENT. The city fire department used 17 public hose streams supplied by low and high service water works and pumpers. Twenty hose companies and ten ladder companies responded to the fire.

Story of the Fire.

In the kitchen on the second floor there is a battery of coal fired ranges. From a metal hood over these, two vent flues extend upward through the building to the roof. The vent of principal interest extends as a sheet metal flue horizontally across the ceiling of the kitchen, turns upward through the ceiling and continues horizontally on the third floor in contact with wooden shelves to a vertical metal lath and plaster flue which extends up to a small roof house, and finally discharges through a fan and metal pipe to the open air. The other vent from the same hood



2. The large amount of water used coupled with the cold weather (17° above zero) festooned the building with ice. The ladder shown in the foreground was frozen in and the extension ladder broke, not, however, while it was against the building.

consists of a metal pipe enclosed in a larger metal lath and plaster flue. Both of these flues pass through a small sprinklered roof house. There is a third ventilating shaft of metal lath and plaster extending through the roof from the kitchen and toilets.

A watchman on the sixth floor, passing the vent flue first described above, saw a glow of fire in the flue through holes where plaster had broken off the metal lath and promptly turned in a public alarm at 8:29 P. M.* The fire department responded with six companies and found fire in the hood in the kitchen, also in the shelves about the flue in the paint department on the third floor, about the flue in the sixth, and in the roof house at the top of the flue. They fought these fires with chemical lines and extinguishers only, and cut holes in the flue at the several stories, tearing away tin work of the roof house, etc. Two sprinklers operated in the kitchen, and three in the "paint department" on the third floor. The fire in its several locations was apparently considered extinguished by 9:10 P. M., but firemen were still in the building at about 9:30 P. M. when it was discovered that a serious fire was in progress in the sixth floor at a point 70 ft. from the top of the flue where trouble had been previously

* Two alarms were given in the first outbreak of fire, one from an adjacent and connecting building. Six companies responding to this alarm found no fire in their district and returned to quarters at 8:49 P. M. These companies were not a factor till later.

3. The ruins of the sixth floor. The sprinklers were out of commission in the section in the foreground. In the background where the roof is intact the sprinklers were operating and held the fire in check.

experienced. Second, third and fourth alarms were sounded at 9:30, 9:33 and 9:43 P. M. respectively, and from then on the fire was fought in the sixth and fifth floors, with great volumes of water. The roof over about one-half of the sixth story was destroyed, and fire extended into the fifth story, through the floor and by the open elevator shaft. Some burning occurred in the remaining portion of the top floor but a partial wall, hose streams and sprinklers prevented entire destruction in this area. The water damage affected all stories in the six-story part and spread out into the four-story section. Water throughout the basement was five feet or more deep the next morning.

Operation of the Sprinklers.

It should be distinctly understood that the following statements are offered not as statements of proven facts, but as the best account that can be deduced from a mass of confused, conflicting, and in some cases apparently prejudiced, evidence from many participants in these events.

As previously stated, two sprinklers opened in the kitchen on the second floor and three on the third floor. On the order of the fire department, apparently after the fires in these areas were extinguished, the night engineer closed valves on risers No. 4 and No. 6 and replacement of sprinklers was started. The time of closing the valves cannot be determined. Sprinklers on No. 4 riser, also feeding sprinklers on sixth floor near the top of the vent shaft, were replaced and the valve on this system was reopened apparently shortly after 9 P. M. by the night engineer. Work was progressing on replacing sprinklers in the kitchen, when a fireman came down and ordered the sprinkler valve opened as fire was going through the roof. The valve on this (No. 6) riser was then opened

at once (about 9:30 P. M.). This valve controlled also sprinklers on the sixth floor, over a part of the area where second outbreak occurred. One of the insurance inspectors on hand during the fire went upstairs but could not reach the sixth floor as the fire was about the head of the stairs. The lights in the building went out about this time. The inspectors received confirmation of all control valves being opened, but noting progress of the fire became suspicious, and after some delay in finding the engineer familiar with the valves and the basement, started a detailed examination of the valves. This was done at considerable personal risk as the congested basement was dark, wet and smoky. All valves were found open, except valve on No. 7 riser, which was found closed, and was opened at 10:15 P. M. This valve controlled the area on the sixth floor where the second outbreak of fire occurred. This system was not involved in the first outbreak, and there is no evidence of any sort as to why or when or by whom it was closed. Its obscure and distant location seems to preclude the assumption of its being closed by mistake. Inspection by an insurance engineer two days before the fire is said to have showed the valve open then. The No. 6 system being shut off at the second outbreak and the No. 7 system being shut off for 45 minutes thereafter is the explanation of the severe loss experienced.

Some Comments on the Second Outbreak.

The point on the sixth floor where second outbreak occurred was 70 ft. or more from the vent shaft where the fire was first fought, and a lengthy inquiry into the circumstances fails to reveal any wholly satisfactory explanation as to the relation of the two outbreaks as to cause. This inquiry included consideration of the possibility of fire entering the sixth floor from another of the flues from the kitchen. It appears reasonable to assume that the two outbreaks occurred as a result of the same fire in the kitchen, but it has been suggested that two separate fires occurred. It seems impossible to prove or disprove either assumption, but as previously stated the weight of the evidence seems to support a single fire cause.

The apparent severity of the second outbreak at the time of its discovery appears to put the fire department in the unenviable position of having to defend attacks upon its thoroughness in inspecting and patrolling the building after the first outbreak. The scene of the second outbreak was not directly visible from that of the first on the sixth floor, and was in an area congested by high stock shelves, where a large stock of toys and other goods were stored and in which fire would at first be concealed and then break out with severity. The report of the fire department covering its patrol of the sixth floor and report of discovery of the second outbreak is unsatisfactory.

Points of Interest.

During the night many hose streams were used and water was being discharged from many sprinklers. The water pressure was ample at all times. The water flooding the basement prevented access to sprinkler valves and resulted in a waste of water during the morning hours. It was necessary to cut holes in the first floor the morning after the fire to reach the valves to shut off the flow from the sprinklers.

4. The vent flue in which the fire was discovered is shown just to the right of the chimney. Sprinklers in this section were out of commission for about an hour during the first stages of the fire.

Water in the basement got into a fuel oil tank through a manhole carelessly left uncovered and the floating oil did much damage and resulted in a hazardous condition after water was pumped out.

Wired glass windows in the sixth floor of the building seriously hampered the firemen in putting hose streams into the fire area from neighboring buildings.

The inefficiency of sprinklers, staggered in alternate narrow bays, in severe fire conditions was amply evidenced by the condition of the remaining roof. Nevertheless, the operation of sprinklers in certain areas of the top floor may quite truly be said to have been a vital factor in preventing the destruction of the building and possibly a conflagration.

The narrow streets and lack of sufficient water towers hampered the fire fighting efforts. It would appear that the fire department should have added facilities and training for fighting fires in six-story and higher buildings.

The need of a protective department in the city is most emphatically shown.

Getto Building Fire, Wichita, Kansas.

Report by Kansas Inspection Bureau.

(Member N. F. P. A.)

A fire which occurred on February 5, 1923, in the Getto Building, Wichita, Kan., occupied as a meat market and rooming house, caused the death of nine persons and completely destroyed the building. Poor construction and inadequate interior protection were largely responsible for the rapid spread of the fire and the loss of life.

The building was four stories and basement, of brick and wooden joisted construction. There were two open stairways to each floor. The first floor was partly vacant and partly occupied by a grocery and meat market. The three upper floors were occupied by 63 roomers in 48 rooms. The only interior protection was two 2½ gallon extinguishers on each of the upper three floors.

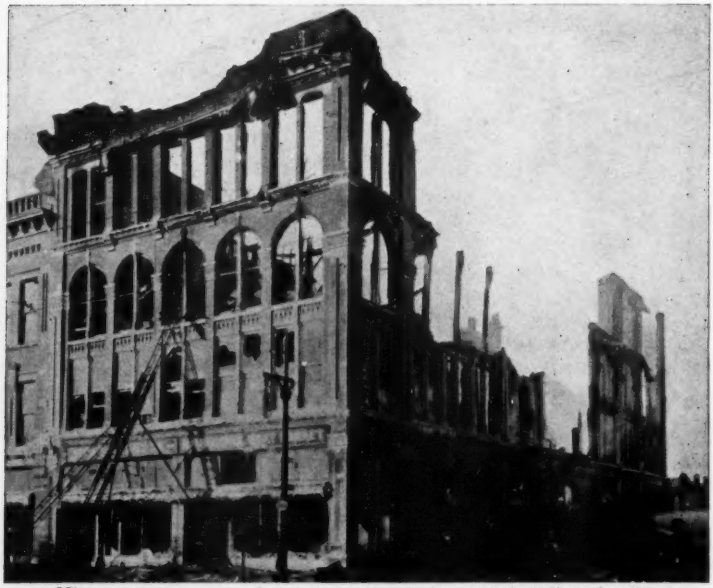
Story of the Fire.

The fire was discovered by a police officer and reported by telephone to Fire Headquarters at 3:12 A. M. At this time the north stairway was a solid mass of flames and before the fire department arrived the whole building was in flames and fire burning through the roof. Numerous other alarms were turned in soon after and it was reported that there was difficulty in getting central and the alarm greatly delayed. Investigation shows that a great many people were trying to report the fire at the same time which accounted for the inability to get central. It developed that no material delay was experienced and the fire department responded and was functioning very soon after the discovery of the fire.

No definite conclusions as to the origin of the fire have been reached. The fire seemed to have originated in the rear or north hall near the stairway on the first floor, but as the fire was not discovered until the second and third hallways were all in flames, this is only a guess. The occupants of the building had no warning until awakened by fire and smoke in their rooms.

The fire had made such headway by the time of the arrival of the fire department that the efforts of the department were directed to saving people and the neighboring property. A four-story office and apartment building across a 70-ft. street north was in great danger for a time and most of the windows were broken out by the intense heat and some were burned out. A one-story brick garage building across a 20-ft. alley to the west was slightly damaged.

Soon after the arrival of the department the roof, floors and west wall fell in and the fourth story wall on the south in falling broke through the roof of a three-story building adjoining on the south causing some water damage. The north wall of the building fell in the street, but as the hottest part of the fire was near the rear the front wall did not fall and some of the floors near the front were left in place.



Nine persons were burned to death in this building in Wichita, Kansas. Poor construction and protection were responsible for the rapid spread of the fire.

A large number of electric light and power wires were in danger of falling in the street and endangering the lives of firemen by the burning of poles 60 feet across the street on the north.

The fire was fought with special attention to keeping the fire from spreading to surrounding property. It was under control by 5 A. M.

Loss of Life.

As all records of the names and numbers of roomers and tenants were destroyed by the fire, it was impossible to make a definite checkup. Nine bodies were recovered from the ruins. The fire was so intense and spread so quickly that there was barely time for the fortunate ones to make their escape by the means of fire escapes, ropes and the aid of the firemen. Many who made their escape were injured or severely burned. Owing to the fact that the bodies were so badly burned and disfigured identification was impossible. Burial was at the direction and expense of the county.

Conclusions.

1. An automatic fire alarm system might have saved many lives.
2. The importance of rope fire escapes as well as the regular iron fire escape was demonstrated as these were the only means of escape.
3. The open stairways and light court were the cause of the rapid spread of the fire.
4. Electric wires above ground are dangerous and obstruct the fighting of fires and should be placed in underground conduits.

5. The necessity of wired glass windows was demonstrated by the loss from exposure at a distance of 70 feet.

6. The value of the Fire Department drill school was demonstrated by the efficient work of the department in saving lives and fighting the fire.

Fires in Which There Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred, that they may be known and guarded against.

Rooming House and Garage.

H-19125: KANSAS CITY, KAN., FEBRUARY 23, 1923. A fire which gutted a two-story frame building occupied as an 18-room rooming house with a garage below caused the death of thirteen persons. The building was a typical fire trap housing thirty-five persons on the upper floor. The entire first floor of the building was used as a garage and the fire, starting from unknown cause, progressed very rapidly.

The unusual construction of the stairways trapped several persons in the building. The stairs led up to a center corridor on the second floor. At the head of the stairs, corridors branched in four directions. Persons, blinded by smoke, coming from one side of the building, could easily run by the head of the stairs and on into the other side. Three bodies were found at the top of this stairway. The persons that did escape ran down the stairs before the fire had cut them off. The building collapsed fifteen minutes after the fire started.

An ordinance prohibiting rooming houses over garages had been presented by the city building inspector some time before the fire but it was defeated.

Poolroom and Apartment.

H-19129: COPREOL, ONT., JANUARY 5, 1923. The building was a two-story frame structure, with the lower story occupied as a poolroom and the upper story as apartments, with seven tenants at the time of the fire. The temperature was 30° below zero. The poolroom was heated by a large wood stove and pipes from this stove ran the whole length of the room. The fire, which started about midnight, was probably due to the overheating of this stove. The whole building became a mass of flame in a very short time. All the occupants escaped but one who burned to death. Another lodger returned to the building for some belongings and was trapped and also burned to death.

On account of the extreme cold the town fire pump could not be put in operation. Three stores, four apartments, and several other buildings, all of frame construction, were destroyed.

Tenement.

H-19130: LAWRENCE, MASS., JANUARY 20, 1923. Eight lives were lost in a fire in a three-story and attic brick tenement building. The structure was a typical fire trap with wood lath and plaster partitions and open

stairways. The cause of the fire was not definitely determined. It is thought that it may have originated in a coal gas explosion. The fire occurred shortly before 1 A. M. An outsider who first perceived the fire ran up and down the street for several minutes before locating a policeman who turned in the alarm. This delay gave the fire headway and the occupants who were caught did not have a chance to escape.

School.

H-19134: PITTSFIELD, MASS., FEBRUARY 17, 1923. A fire which destroyed five connecting frame buildings of a girls' school cost the life of one woman. The cause of the fire was the clogging of soft coal soot in a chimney. Sixty-seven students in a large room escaped through the windows. The ceiling of the room fell five minutes later. A waitress, who was ill in her room, lost her way in the smoke-filled corridors and was burned to death.

Almshouse.

H-19135: ANGELICA, N. Y., MARCH 15, 1923. A fire, which broke out at midnight, resulted in the death of seven women inmates and two employees at the Allegheny County almshouse. The buildings, with the exception of one concrete structure, were old frame structures interconnected with passageways. The fire started from a gas explosion in the basement of a two-story wooden structure where 24 women patients were quartered. A janitor was killed by the explosion. Six of the aged women were cremated in their beds and the seventh was killed when she jumped from a second story window. One employee was burned to death while trying to rescue some of the inmates.

The fire, fanned by a high wind, swept along the passageways to the other buildings. The buildings had no fire protection of any sort and as they were three miles from the village the firemen did not arrive until the fire had burned itself out. All of the buildings except the concrete structure were destroyed.

Hotel.

H-19002: VAN BUREN, ME., APRIL 3, 1923. A fire due to an overheated stove caused the death of five persons in a small frame country hotel. The fire broke out at 3 o'clock in the morning. There were fifteen persons in the hotel at the time. The stove was on the ground floor in the hall and escape from the only stairway was cut off. The fire spread rapidly and the victims had no chance of escape. Those persons who escaped either jumped from windows or were taken down ladders.

Dust Explosion.

S-34310: YORK HAVEN, PA., FEBRUARY 8, 1923. The fire occurred in a part of the plant used for manufacturing a product from sulphide pulp refuse for use as a road spray and binder. The building was one high story with brick walls and large areas of wired glass in metal frame. The product will not burn in the liquid state but in the dry powdered form will burn if ignited.

The dryer in this building consisted of two round chambers, constructed of 4 in. hollow tile and concrete, and extending from the floor level to within four feet of the roof. These chambers are connected at the top. The liquid product is sprayed in at the top of one chamber which is

previously heated up by air which passes over steam pipes. The liquid is immediately turned to powder and the powder passes into the other chamber through a fan and is collected at the bottom.

The night shift operating the dryer had noticed a peculiar odor for several hours and mentioned this fact to the day shift when they came on duty. The day shift men were more experienced and immediately started to shut down. One man was sent to the top of the dryer to shut off the spray but before he could get down there was an explosion and he was thrown to an adjacent platform. He was badly burned and died a few hours afterward. The tops of both chambers were blown off and numerous wired glass windows were blown out. The explosion was followed by a flash of flame which shot 100 feet into the air. Several men on the floor were blown out through the doorways.

The heat in the dryer had reached a point high enough to ignite the powdered material and just as the men started to shut down the dryer the mixture of air and dust was in the correct proportion for an explosion.

Inflammable Film.

H-19127: BAR HARBOR, ME., JANUARY 19, 1923. The fire occurred in a barracks of the Naval Radio Station near Bar Harbor. The building was used for officers on the ground floor and a recreation hall on the upper floor. Two men were in a motion picture booth preparing for a show. About fifty persons were in the hall attending the exhibition. The operators found a reel in poor condition and had trouble in winding it. One of them removed the arc shade from in front of the light without starting the machine and the film immediately ignited. He threw the burning reel out of the door of the booth and both men escaped from the booth through the top into a loft above the hall. One of these men was trapped in the loft and burned to death. The other managed to break through the ceiling and he fell to the hall below and escaped. The picture booth was at the head of the only stairway. The people in the hall had to jump from the windows but fortunately deep snow outside saved them from being hurt. The building was destroyed.

Lighted Candles.

H-19128: NEWPORT POINT, QUE., MARCH 19, 1923. A child in the house had died and the family, consisting of father and mother and three children, retired, leaving the body in a coffin surrounded by candles. During the night one of the candles set fire to a curtain and the small frame house burned rapidly. Two of the children were burned to death and the third, three weeks old, was killed when the mother, herself probably fatally injured, jumped from a window with the babe in her arms.

Gasoline.

H-19137: EUGENE, ORE., DECEMBER 7, 1922. Five children were burned to death and five other persons seriously injured as a result of a fire which destroyed their home. The blaze was started by the explosion of a five gallon can of gasoline. The gasoline was used to start a fire in the kitchen stove.

Kerosene.

H-19136: CHICAGO, ILL., DECEMBER 7, 1922. Four children were burned to death and four other persons seriously injured when their home

was destroyed by fire. A high wind sweeping through an open window blew over a kerosene lamp. The family had all retired and as the house was of frame construction the fire spread rapidly.

H-19131: NEW BEDFORD, MASS., JANUARY 21, 1923. A woman who lived alone attempted to start up the fire in her kitchen stove with kerosene. A flash fire ensued and she was enveloped in flames. She tried to open the door and neighbors also tried to break down the door without success. When it was finally opened she was beyond recovery.

H-19133: CEDAR RAPIDS, IA., FEBRUARY 5, 1923. A young woman was burned to death when kerosene, which she poured into a stove, caused a flash fire, enveloping her body in flames. She was alone in the house at the time and was badly burned before help arrived. Her five-year-old son was playing outside and ran in to help, narrowly escaping a similar death.

H-19132: CAMBRIDGE, MASS., MARCH 13, 1923. Two children were suffocated when they hid under a bed during a fire in their home. The children with their aged grandmother went down to the cellar about 7:30 P. M. for coal. The boy, aged four, carried an oil lamp to light the way. The lamp slipped from his hands and caused a flash fire. The children rushed upstairs to their bedroom. The aged woman managed to reach the door and threw herself in the snow in the street. This action saved her life. Firemen forced their way up to the second floor and found the children. Flames had not reached the room but it was full of dense smoke.

Annual Summary.

Statistics of Fires in Properties Having Automatic Sprinkler Protection.

NOTE.—These tabulations are made at the close of each fiscal year, with the object of furnishing a basis upon which the virtue of the automatic sprinkler as an extinguishing agent can be estimated.

Section I is devoted to fires in which the behavior of sprinklers was, for the reasons given, unsatisfactory.

Section II is a statistical record of all reports of sprinkler fires in the files of the Association upon which the information obtained is sufficiently complete for statistical purposes.

In each table the results of the current year ending February 1, 1923, are given, and these are compared with the results of the total twenty-six year record ending at that time.

Section III includes tables giving data on the efficiency of the primary water supply to sprinkler systems.

The total number of sprinklered fire reports received during the past year is 2550. The number of fires in which the sprinklers were not a factor* or which were discovered and extinguished before there was sufficient heat to open the sprinklers was 624. This compares with 698 for the year ending February, 1922, and 971 for the year ending, April, 1921. The number of fires in which sprinklers operated is 1926 as compared with 1558 last year. The number of failures for the two years are respectively 83 and 67, making the per cent of satisfactory operation 95.7 and 95.9.

The sprinkler alarm shows a satisfactory performance of 98.7 per cent in 380 fires during the year, making its average for the twenty-six year period 95.3 per cent satisfactory.

The supervisory alarm service shows only one failure in 60 fires for the same period.

The tables on Number of Sprinklers Operating show that 76 per cent of the fires during the year were extinguished with five or less heads operating. Comparing wet and dry systems in this respect, 81.2 per cent of the wet system fires were extinguished with five or less heads and 51.5 per cent of the dry system fires. This difference is presumably due to the slower operation of the dry system. Table No. 6 shows that the wet system has a slightly better record of satisfactory performance. It is interesting to note that the total percentage of satisfactory performance for the year, namely 95.7 per cent, is exactly the average for the twenty-six year period.

Starch and glucose works show the highest percentage of sprinkler failures, 30.3 per cent in 23 fires. This occupancy is followed by Grain Elevators with 24.6 per cent in 69 fires, and Saw and Planing Mills with 23.3 per cent in 185 fires.

The secondary water supply was called on in 35.6 per cent of the Oil Cloth and Linoleum Works fires, 24.6 per cent of the Grain Elevator fires,

*By not a factor is meant fires that occur in unsprinklered portions of a building.

and 21.2 per cent of the Cotton Seed Oil mill fires. These are all occupancies liable to severe fires.

The tables show that the public waterworks is the most popular form of primary supply with the steam pump as a secondary supply. The relative efficiency of the various forms of primary supply remains the same as in previous tables.

SECTION I.

Summary of Unsatisfactory Sprinkler Fires.

	1922-1923		1897-1923, incl.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Water shut off sprinklers	28	33.8	360	29.3
Generally defective equipment	6	7.2	249	20.0
Unsprinklered portions	4	4.8		
Defective water supply or supplies	5	6.0	111	9.3
Sprinkler system crippled due to freezing	2	2.4	41	3.3
Slow operation of dry system or defective valve	7	8.5	33	2.7
Slow or defective operation of high test heads	3	3.6	22	1.8
Faulty building construction, concealed spaces, vertical openings, etc.	6	7.2	62	5.1
Obstruction to distribution	7	8.5	70	5.7
Hazard of occupancy too severe for average sprinkler equipment	8	9.6	70	5.7
Explosion crippled sprinkler system	..	..	55	4.5
Exposure or conflagration	..	..	71	5.8
Plugged heads (included with Miscellaneous prior to 1921)	3	3.6	6	.5
Miscellaneous	4	4.8	77	6.3
Total	83		1227	

Special Classification of Fires in Which Failure Was Due to Water Being Shut Off Sprinklers.

	1922-1923. No. of Fires.	1897-1923. No. of Fires.
Water shut off for unknown reason, neglect or carelessness	7	134
Water shut off before fire was out or fire rekindled	6	54
Water shut off due to accidents or repairs	3	60
Water shut off to prevent freezing	7	73
Water shut off, probably incendiary	..	6
Water shut off, leaky dry system	..	11
Water shut off, miscellaneous	3	15
Water shut off, defective gate valve	2	7
Total	28	360

SECTION II.

Annual Revision of Sprinkler Fire Tables.

In the following eleven tables is given a summary of fires occurring in properties equipped with automatic sprinklers. The total number of such fires reported during the past year is 2550, which includes 624 fires where no sprinklers were opened. Several reports were also received in which the data was incomplete, and these were not used in the summary. It may be noted that the total number of fires does not agree throughout all the tables. This is because some of the reports of fires prior to 1909 were not considered sufficiently complete to include in all the tables, and hence appear in some tables, but not in others.

Table No. 1—Time of Day.

	1922-1923.		1897-1923.	
	No. of Fires.	Per Cent	No. of Fires.	Per Cent
6 a. m. to 6 p. m.	959	50.1	15008	56.6
6 p. m. to 6 a. m.	954	49.9	11535	43.4
Total with data given	1913		26543	
No data	13		463	
Total	1926		27006	

Table No. 2—How Discovered.

	1922-1923.		1897-1923.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Employee	846	44.0	15075	57.1
Watchman	246	12.8	3901	14.8
Sprinkler Alarm	565	29.4	4654	17.6
Outsider	141	7.3	1436	5.4
Thermostats	30	1.6	779	2.9
Supervisory System	95	4.9	589	2.2
Total with data given	1923		26434	
No data	3		572	
Total	1926		27006	

Table No. 3—Efficiency of Alarm Service, 1922-1923.

NOTE: This table does not include fires where alarm service does or does not operate promptly if fire is at once discovered by employees, the alarm service having no bearing on such fires one way or the other.

	Satisfactory.		Failure.		Total.
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	
Watchman alone	119	95.2	6	4.8	125
Sprinkler Alarm alone	375	98.7	5	1.3	380
Thermostats alone	4	100.0	..	..	4
Supervisory System alone	1	100.0	..	..	1

Table No. 3—Efficiency of Alarm Service, 1922-1923—Continued.

	Watchman.		Sprinkler Alarm.		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman and Sprinkler Alarm	127	98	213	12	..	..	..	..	225
Sprinkler Alarm and Thermostats	..	..	20	2	20	2	..	..	22
Watchman, Sprinkler Alarm and Thermostats	3	3	6	..	4	2	..	..	6
Sprinkler Alarm and Supervisory	..	..	130	2	..	..	132	..	132
Watchman, Sprinkler Alarm and Supervisory	6	40	46	..	..	..	46	..	46
Sprinkler Alarm, Thermostats and Supervisory	..	..	9	..	7	2	9	..	9

Efficiency of Alarm Service, 1897-1923, Inclusive.

	Satisfactory.		Failure.		
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	Total.
Watchman alone	2207	90.9	220	9.1	2427
Sprinkler Alarm alone	2823	95.3	139	4.7	2962
Thermostats alone	221	81.5	50	18.5	271
Supervisory alone	60	98.5	1	1.5	61

	Watchman.		Sprinkler Alarm.		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman and Sprinkler Alarm	1639	1108*	2448	299	..	..	..	..	2747
Watchman and Thermostats	20	10*	..	..	28	2	..	..	30
Sprinkler Alarm and Thermostats	..	..	579	45	490	134	..	..	624
Watchman, Sprinkler Alarm and Thermostats	49	84*	124	9	99	34	..	..	133
Sprinkler Alarm and Supervisory	..	..	761	15	..	..	768	8	776
Watchman and Supervisory	12	9*	..	..	..	..	21	..	21
Watchman, Sprinkler Alarm and Supervisory	106	280*	375	11	..	..	374	12	386
Sprinkler Alarm, Thermostats and Supervisory	..	..	86	3	74	15	88	1	89
Watchman, Sprinkler Alarm, Supervisory and Thermostats	1	1	2	..	2	..	2	..	2

* These include fires where sprinkler alarm or thermostat notified the watchman.

Table No. 4—Number of Sprinklers Operating.

No. of Sprinklers Operating	No. of Fires, 1922-1923. Wet	%	Dry	%	No Data	Total	%	No. of Fires, 1897-1923, incl. Wet	%	Dry	%	No Data	Total	%
1	638	40.9	51	15.9	4	693	36.6	8346	35.7	922	19.4	13	9281	32.9
2	290	18.5	54	16.9	2	346	18.2	4121	17.7	659	13.8	4	4784	17.0
3	158	10.1	26	8.1	2	186	9.8	2360	10.1	400	8.4	2	2762	9.8
4	111	7.1	22	6.9		133	7.0	1679	7.2	350	7.3	3	2032	7.2
5	72	4.6	12	3.7		84	4.4	1063	4.6	220	4.6	2	1285	4.6
6	45	2.9	16	5.0	1	62	3.3	854	3.6	211	4.4	3	1068	3.8
7	37	2.4	14	4.4		51	2.7	582	2.5	150	3.1	1	733	2.6
8	33	2.1	7	2.2		40	2.1	551	2.4	140	2.9		691	2.5
9	19	1.2	6	1.9		25	1.3	352	1.5	103	2.2		455	1.6
10	16	1.0	7	2.2		23	1.2	326	1.4	95	2.0	1	422	1.5
11	13	.9	11	3.4		24	1.3	244	1.0	89	1.9		333	1.2
12	10	.6	5	1.6	1	16	.9	285	1.2	100	2.1	1	386	1.4
13	10	.6	6	1.9		16	.9	154	.7	77	1.6		231	.8
14	8	.5	4	1.3		12	.6	180	.8	73	1.5	1	254	.9
15	12	.8	8	2.5		20	1.1	148	.6	74	1.5	1	223	.8
16 to 20.....	24	1.5	15	4.7		39	2.0	510	2.2	219	4.6	2	731	2.6
21 to 25.....	5	.3	16	5.0		21	1.1	301	1.3	162	3.4		463	1.6
26 to 30.....	13	.9	9	2.8		22	1.2	227	1.0	102	2.2		329	1.2
31 to 35.....	7	.4	5	1.6		12	.6	146	.6	66	1.4	1	213	.8
36 to 40.....	10	.6	7	2.2		17	.9	125	.5	63	1.3		188	.7
41 to 50.....	7	.4	2	.6	1	10	.5	154	.7	93	1.9	1	248	.9
51 to 75.....	8	.5	5	1.6	1	14	.7	207	.9	121	2.5	1	329	1.2
76 to 100.....	6	.4	1	.3		7	.4	87	.4	58	1.2	1	146	.5
Over 100	12	.8	11	3.4		23	1.2	318	1.4	229	4.8		547	1.9
No Data	13		9		8	30		24		20		382	426	
Total 1577			329		20	1926		23344		4796		420	28560	
Water shut off sprinklers														270
Total														28830

Table No. 5—Number of Sprinklers Operating.

No. of Sprinklers Operating.	No. of Fires 1897-1923, incl. Wet	%	Dry	%	No Data	Total	%
1	8346	35.8	922	19.3	13	9281	33.0
2 or less....	12467	53.5	1581	31.2	17	14065	50.0
3 or less....	14827	63.6	1981	41.5	19	16827	60.0
4 or less....	16506	70.8	2331	48.8	22	18859	67.1
5 or less....	17569	75.3	2551	53.5	24	20144	71.6
6 or less....	18423	79.0	2762	57.9	27	21212	75.5
7 or less....	19005	81.6	2912	60.9	28	21945	78.0
8 or less....	19556	83.6	3052	64.0	28	22636	80.6
9 or less....	19908	85.4	3155	66.1	28	23091	82.4
10 or less....	20234	86.8	3250	68.1	29	23513	83.6
11 or less....	20478	87.8	3339	69.8	29	23846	84.9
12 or less....	20763	88.9	3439	72.0	30	24232	86.3
13 or less....	20917	89.6	3516	73.5	30	24463	87.0
14 or less....	21097	90.5	3589	75.1	31	24717	87.8
15 or less.....21245		91.2	3663	76.7	32	24940	88.7
20 or less....	21755	93.1	3882	81.3	34	25671	91.4
25 or less.....22056		94.6	4044	84.5	34	26134	92.7
30 or less....	22283	95.6	4146	86.6	34	26463	94.2
35 or less....	22429	96.4	4212	88.3	35	26676	94.9
40 or less....	22554	96.6	4275	89.5	35	26864	95.6
50 or less....	22708	97.4	4368	91.3	36	27112	96.5

Table No. 5—Continued.

No. of Sprinklers Operating.	No. of Fires 1897-1923, inclusive. Wet	%	Dry	%	No Data	Total	%
75 or less....	22915	98.2	4489	94.0	37	27441	97.7
100 or less....	23002	98.7	4547	95.2	38	27587	98.0
Over 100	318	1.3	229	4.8		547	2.0
No Data	24		20		382	426	
	23344		4796		420	28560	
Water shut off sprinklers						270	
Total						28830	

Table No. 6.—Effect of Sprinklers, Wet and Dry Systems.

	1922-1923 No. of Fires.							1897-1923, incl. No. of Fires.						
	Wet	%	Dry	%	No Data	Total	%	Wet	%	Dry	%	No Data	Total	%
Practically or entirely extinguished .	1143	72.6	202	61.5	6	1351	70.2	15861	66.5	3127	63.6	19	19007	66.0
Held fire in check	390	24.7	99	30.0	3	492	25.5	7111	29.8	1461	29.8	11	8583	29.7
Total Satisfactory	1533	97.3	301	91.5	9	1843	95.7	22972	96.3	4588	93.4	30	27590	95.7
Unsatisfactory	44	2.7	28	8.5	11	83	4.3	879	3.7	325	6.6	20	1224	4.3
Total	1577		329		20	1926		23851		4913		50	28814	

Table No. 7—Primary Water Supplies to Sprinklers Opened.

	1922-1923 No. of Fires.	Per Cent	1897-1923, incl. No. of Fires	Per Cent
Waterworks	955	50.3	13758	52.5
Gravity Tank	332	17.5	6400	24.4
Pressure Tank	515	27.1	4626	17.6
Pumps	96	5.1	1409	5.4
Steamer Connection.....	..	..	3	.1
Total with data given....	1898		26196	
No Data	28		540	
Water shut off system....	..		270	
Total	1926		27006	

Table No. 8

Showing Effect of Sprinklers by Class of Occupancy.

	Extinguished Fire		Held Fire in Check		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Agricultural Implements	52	57.7	34	37.8	86	95.5	4	4.5	90
Alcohol (Wood) Plant	..	....	1	100.0	1	100.0	..	..	1
Apartments	15	93.8	1	6.2	16	100.0	..	..	16
Artificial Leather	10	50.0	8	40.0	18	90.0	2	10.0	20
Automobile and Bicycle Factories	114	57.5	75	37.9	189	95.4	9	4.6	198
Awning Factories	5	71.5	2	28.5	7	100.0	..	..	7
Bag Factories	13	56.5	10	43.5	23	100.0	..	..	23
Bakeries	69	72.6	23	24.2	92	96.8	3	3.2	95
Basket Factories	7	87.5	1	12.5	8	100.0	..	..	8
Bolt, Nut and Screw Works	17	65.5	9	34.5	26	100.0	..	..	26
Boot and Shoe Shops	562	73.7	173	22.8	735	96.5	27	3.5	762
Bottling Works	4	80.0	..	....	4	80.0	1	20.0	5
Braiding Mills	16	84.2	3	15.8	19	100.0	..	..	19
Breweries	5	83.4	1	16.6	6	100.0	..	..	6
Broom Factories	10	58.7	5	29.4	15	88.1	2	11.9	17
Brush Factories	17	77.3	5	22.7	22	100.0	..	..	22
Button Factories	42	82.4	7	13.7	49	96.1	2	3.9	51
Candle Factories	5	50.0	5	50.0	10	100.0	..	..	10
Candy Factories	111	71.6	39	25.2	150	96.8	5	3.2	155
Canning Factories	10	58.8	4	23.5	14	82.3	3	17.7	17
Car Houses	28	46.7	25	41.7	53	88.4	7	11.6	60
Car Works	70	60.9	41	35.6	111	96.5	4	3.5	115
Carpet Mills	159	61.9	89	34.6	248	96.5	9	3.5	257
Carriage and Automobile Body Factories	101	60.8	51	30.8	152	91.6	14	8.4	166
Celluloid (Pyroxylin Plastic)	135	66.7	43	21.3	178	88.0	24	12.0	202
Cement and Plaster Works	4	66.6	1	16.7	5	83.3	1	16.7	6
Cereal Mills	32	65.3	12	24.5	44	89.8	5	10.2	49
Chemical and White Lead	91	58.0	52	33.1	143	91.1	14	8.9	157
Clothing Factories	942	83.2	183	16.1	1125	99.3	8	.7	1133
Clubs	7	77.8	2	22.2	9	100.0	..	..	9
Coffee and Spice Mills	47	66.4	21	29.6	68	96.0	3	4.0	71
Coffin Factories	50	76.9	13	20.0	63	96.9	2	3.1	65
Cold Storage Plants	5	55.6	4	44.4	9	100.0	..	..	9
Cooperage Plants	47	56.0	27	32.1	74	88.1	10	11.9	84
Cordage Works	208	65.3	100	31.2	308	96.5	11	3.5	319
Cork Factories	14	48.2	12	41.4	26	89.6	3	10.4	29
Corset Factories	8	66.7	3	25.0	11	91.7	1	8.3	12
Cotton Ginnery	10	62.5	6	37.5	16	100.0	..	..	16
Cotton Mills	3924	62.0	2342	37.0	6266	99.0	72	1.0	6338
Cotton Warehouses	145	46.2	142	45.5	287	91.7	26	8.3	313
Cotton Seed Oil Mills	39	48.8	28	35.0	67	83.8	13	16.2	80
Cutlery and Tools	23	63.9	11	30.6	34	94.5	2	5.5	36
Department Stores	390	78.3	95	19.1	485	97.4	13	2.6	498
Distilleries	7	63.7	3	27.2	10	90.9	1	9.1	11
Dolls	19	51.4	18	48.6	37	100.0	..	..	37
Drug Houses	169	80.5	37	17.6	206	98.1	4	1.9	210
Dry Cleaning Establishments	6	66.7	3	33.3	9	100.0	..	..	9
Dyeing, Bleaching and Finishing	146	53.7	113	41.5	259	95.2	13	4.8	272
Electrical Appliances	153	71.5	55	25.7	208	97.2	6	2.8	214
Electric Light and Power Plants	4	33.3	6	50.0	10	83.3	2	16.7	12
Elevators, Grain	26	37.7	26	37.7	52	75.4	17	24.6	69
Excelsior Factories	24	77.4	5	16.1	29	93.5	2	6.5	31
Fertilizer Plants	23	62.2	11	29.7	34	91.9	3	8.1	37
Flax and Linen Mills	26	47.2	29	52.8	55	100.0	..	..	55
Flour and Grist Mills	55	55.0	34	34.0	89	89.0	11	11.0	100
Forge and Smithy	16	69.6	6	26.1	22	95.7	1	4.3	23

Table No. 8 — Continued.

	Extinguished Fire		Held Fire in Check		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Foundries	150	58.4	96	37.4	246	95.8	11	4.2	257
Fur Works	27	90.0	3	10.0	30	100.0	..	..	30
Furniture Factories	503	65.1	213	27.5	716	92.6	59	7.4	775
Garages	139	66.8	64	30.8	203	97.6	5	2.4	208
Garbage Reduction Plants	3	60.0	1	20.0	4	80.0	1	20.0	5
Gas Plants	2	66.7	1	33.3	3	100.0	..	..	3
Glass Works	50	52.6	35	36.8	85	89.4	10	10.6	95
Glove Factories	9	69.2	3	23.1	12	92.3	1	7.7	13
Glue Factories	6	50.0	4	33.3	10	83.3	2	16.7	12
Groceries	69	80.2	12	13.8	81	94.0	5	6.0	86
Harness and Fancy Leather	93	82.4	20	17.6	113	100.0	..	..	113
Hat Factories	149	74.1	45	22.4	194	96.5	7	3.5	201
Hatters' Fur Works	12	52.2	8	34.8	20	87.0	3	13.0	23
Hotels	25	73.5	8	23.5	33	97.0	1	3.0	34
Ice Plants	2	100.0	..	....	2	100.0	..	..	2
Incandescent Lamp Factories	13	54.2	11	45.8	24	100.0	..	..	24
Institutions	8	66.7	3	25.0	11	91.7	1	8.3	12
Insulated Wire Factories	31	66.0	16	34.0	47	100.0	..	..	47
Jewelry Factories	126	87.5	12	8.3	138	95.8	6	4.2	144
Junk Shops	17	73.9	5	21.7	22	95.6	1	4.4	23
Knitting Mills, Cop Yarn	40	61.6	19	29.2	59	90.8	6	9.2	65
Knitting Mills, Full Process	477	64.3	240	32.3	717	96.6	25	3.4	742
Laundries	52	73.2	16	22.5	68	95.7	3	4.3	74
Lead Pencil Factories	16	66.7	7	29.2	23	95.9	1	4.1	21
Linseed Oil Works	17	56.7	11	36.7	28	93.4	2	6.6	30
Machine Works	350	68.1	141	27.4	491	95.5	23	4.5	514
Match Factories	51	73.9	14	20.3	65	94.2	4	5.8	69
Mattress Factories	339	71.0	131	27.5	470	98.5	7	1.5	477
Mercantile	866	81.1	181	16.9	1047	98.0	22	2.0	1069
Metal Reduction Works	8	66.7	4	33.3	12	100.0	..	..	12
Metal Workers	800	64.8	385	31.2	1185	96.0	50	4.0	1235
Miscellaneous	443	70.6	153	24.4	596	95.0	31	5.0	627
Morocco Leather Shops	32	52.5	21	34.4	53	86.9	8	13.1	61
Motion Pictures	51	78.4	13	20.0	64	98.4	1	1.6	65
Munition Factories	20	39.2	22	43.2	42	82.4	9	17.6	51
Musical Instrument Factories	114	66.6	51	29.8	165	96.4	6	3.6	171
Office Buildings	21	80.6	5	19.4	26	100.0	..	..	26
Oil Clothing Factories	11	68.8	5	31.2	16	100.0	..	..	16
Oilcloth and Linoleum Works	32	29.9	56	52.3	88	82.2	19	17.8	107
Oil Refineries									
Animal	2	40.0	3	60.0	5	100.0	..	..	5
Mineral	5	83.4	1	16.6	6	100.0	..	..	6
Vegetable	1	14.3	5	71.4	6	85.7	1	14.3	7
Packing House and Slaughter	129	69.4	50	26.9	179	96.3	7	3.7	186
Paint and Color Works	156	69.6	60	26.8	216	96.4	8	3.6	224
Paper Box and Papeterie	156	75.0	48	23.1	204	98.1	4	1.9	208
Paper Mills	365	50.1	305	41.9	670	92.0	59	8.0	729
Patent Leather Works	7	33.3	10	47.6	17	80.9	4	19.1	21
Phonograph Works	18	75.0	5	20.8	23	95.8	1	4.2	24
Photographic Works	22	75.8	6	20.7	28	96.5	1	3.5	29
Picture Frame Factories	39	64.0	16	26.2	55	90.2	6	9.8	61
Plumbers' Supplies	20	80.0	5	20.0	25	100.0	..	..	25
Potteries	44	63.7	21	30.4	65	94.1	4	5.9	69
Printing and Lithographing	579	80.5	122	17.0	701	97.5	17	2.5	718
Pulp Mills	30	35.3	39	45.9	69	81.2	16	18.8	85
Restaurants	42	82.4	8	15.7	50	98.1	1	1.9	51
Rice Mills	1	50.0	1	50.0	2	100.0	..	..	2
Rolling, Wire and Tube Works	26	57.8	17	37.8	43	95.6	2	4.4	45
Roofing Works	23	36.5	34	53.9	57	90.4	6	9.6	63

Table No. 8 — Concluded.

	Extinguished Fire		Held Fire in Check		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Rubber Cloth Factories	26	60.5	17	39.5	43	100.0	..	..	43
Rubber Reclaiming Works	6	35.3	9	52.9	15	88.2	2	11.8	17
Rubber Works	130	49.6	115	43.9	245	93.5	17	6.5	262
Saw and Planing Mills	81	43.8	61	32.9	142	76.7	43	23.3	185
Schools	7	70.0	3	30.0	10	100.0	..	..	10
Shirt Factories	45	86.5	7	13.5	52	100.0	..	..	52
Shoddy Mills	192	65.7	80	27.4	272	93.1	20	6.9	292
Silk Mills	75	74.3	22	21.8	97	96.1	4	3.9	101
Skin Mills	2	66.7	1	33.3	3	100.0	..	..	3
Soap Manufacturing	34	79.0	8	18.6	42	97.6	1	2.4	43
Stamping and Sheet Metal Works	58	61.8	29	30.9	87	92.7	7	7.3	94
Starch and Glucose Works	12	52.3	4	17.4	16	69.7	7	30.3	23
Sticky Fly Paper Factories	3	75.0	1	25.0	4	100.0	..	..	4
Sugar Refineries	20	64.5	10	32.3	30	96.8	1	3.2	31
Tanneries	43	52.5	32	39.0	75	91.5	7	8.5	82
Tenant Manufacturing	635	73.8	180	20.9	815	94.7	46	5.3	861
Theatres	45	72.6	14	22.6	59	95.2	3	4.8	62
Tobacco Factories	51	69.9	19	26.1	70	96.0	3	4.0	73
Trunk Factories	15	68.2	5	22.7	20	90.9	2	9.1	22
Varnish Works	18	58.0	11	35.5	29	93.5	2	6.5	31
Wall Paper Factories	13	68.5	3	15.8	16	84.3	3	15.7	19
Warehouses	329	70.6	114	24.4	443	95.0	23	5.0	466
Waste and Batting Mills	245	61.3	140	35.0	385	96.3	15	3.7	400
Waste Paper and Rag Shops	68	62.5	38	34.8	106	97.3	3	2.7	109
Weaving Mills	115	65.6	56	32.0	171	97.6	4	2.4	175
Whip Factories	4	66.7	2	33.3	6	100.0	..	..	6
Window Shade Factories	10	83.4	..	....	10	83.4	2	16.6	12
Woodworkers, Class A*	139	53.9	83	32.2	222	86.1	36	13.9	258
Woodworkers, Class B*	144	52.2	104	37.7	248	89.9	28	10.1	276
Woodworkers, Class C*	125	60.6	71	34.5	196	95.1	10	4.9	206
Woodworkers, Class D*	87	58.0	44	29.3	131	87.3	19	12.7	150
Woodworkers, Class E*	143	63.8	70	31.3	213	95.1	11	4.9	224
Woodworkers, Class F*	34	60.8	18	32.1	52	92.9	4	7.1	56
Woolen Mills	896	70.4	315	24.8	1211	95.2	61	4.8	1272
Wool Storehouses	27	71.1	9	23.6	36	94.7	2	5.3	38
Worsted Mills	55	51.4	38	35.5	93	86.9	14	13.1	107
Total Sprinkler Fires	19,008		8,579		27,587		1,227		28,814

*The Woodworkers are classed as follows:

Class A. Interior Woodwork, builders' supplies (including veneer works).

Class B. Box Factories (including cigar boxes).

Class C. Miscellaneous Woodworkers. Steam power tenant Woodworkers. Woodworkers where there is a lack of detailed information as to class.

Class D. Sash, Door and Blind Factories.

Class E. Hard Wood Turning (wheels, pipes, novelties, bobbins, spools, etc., last and wood heel factories).

Class F. Pails and Woodenware. (Plates, wooden bowls, tubs, etc.)

Table No. 9

Classification of Unsatisfactory Sprinkler Fires by Occupancy.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged Heads.	Miscellaneous.	Total.
Agricultural Implements	3	..	..	..	..	..	..	..	1	..	..	..	..	4
Artificial Leather	..	..	..	..	..	..	1	..	..	1	..	..	..	2
Automobile and Bicycle	4	1	1	..	..	..	..	2	..	..	1	..	..	9
Bakeries	1	1	..	..	..	..	..	..	..	..	..	..	1	3
Boot and Shoe Shops	10	5	2	..	..	1	..	1	..	2	5	..	1	27
Bottling Works	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Broom Factories	2	..	..	..	..	..	..	..	..	..	..	..	..	2
Button Factories	..	..	..	2	..	..	..	..	..	..	..	..	..	2
Candy Factories	2	..	..	..	1	..	2	..	..	..	..	..	..	5
Canning Works	1	..	..	..	1	..	..	..	..	..	1	..	..	3
Car Houses	2	2	1	..	1	..	..	1	..	..	..	..	..	7
Car Works	1	1	..	..	..	..	1	1	..	..	..	..	..	4
Carpet Mills	4	1	3	..	..	..	..	1	..	..	..	..	..	9
Carriage Factories	2	4	3	..	1	..	..	1	1	..	2	..	..	14
Celluloid (Pyroxylin)	1	..	3	1	1	..	2	2	7	5	2	..	..	24
Cement and Plaster Works	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Cereal Mills	..	2	1	..	..	..	..	..	..	2	..	..	..	5
Chemical and White Lead	2	4	..	..	..	..	..	..	4	4	..	..	..	14
Clothing Factories	3	..	1	1	..	..	2	1	..	..	..	..	..	8
Coffee and Spice Mills	2	..	..	..	..	..	..	..	..	1	..	..	..	3
Coffin Factories	1	..	..	1	..	..	..	..	..	..	..	..	..	2
Cooperage Plants	1	3	..	..	..	1	..	4	..	..	1	..	..	10
Cordage Works	2	4	1	1	..	..	..	2	..	..	..	..	1	11
Cork Factories	1	..	1	..	..	..	..	..	..	1	..	..	..	3
Corset Factories	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Cotton Mills	25	18	6	2	..	1	5	1	3	..	..	2	9	72
Cotton Warehouses	14	1	2	..	..	..	1	4	2	..	..	..	2	26
Cotton Seed Oil Mills	3	4	2	..	..	..	..	..	1	..	..	..	3	13
Cutlery and Hardware	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Department Stores	4	3	..	..	1	..	1	1	..	..	2	..	1	13
Distilleries	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Drug Houses	..	..	..	..	..	..	..	..	..	..	3	..	1	4
Dyeing, Bleaching and Finishing	4	3	1	..	1	1	..	1	..	..	1	..	1	13
Electrical Appliances	2	..	2	..	..	..	1	..	..	..	..	..	1	6
Electric Light and Power Plants	..	1	..	..	..	..	..	1	..	..	..	..	..	2
Elevators, Grain	..	3	5	..	1	..	2	1	1	1	2	..	1	17
Excelsior Factories	..	..	1	..	..	..	..	..	1	..	..	..	..	2
Fertilizer Plants	2	..	..	..	1	..	..	..	..	..	..	..	..	3
Flour and Grist Mills	1	2	1	..	1	..	1	..	..	3	2	..	..	11
Forge and Smithy	..	..	..	..	..	..	..	1	..	..	..	..	..	1
Foundries	8	1	1	..	..	..	..	..	..	1	..	..	..	11
Furniture Factories	19	13	2	3	..	..	2	9	7	..	4	..	..	59
Garages	3	..	..	..	..	..	..	2	..	..	..	..	..	5

Table No. 9—Continued.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged Heads.	Miscellaneous.	Total.
Garbage Reduction Plants	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Glass Works	1	1	2	1	..	..	1	1	..	..	..	..	3	10
Glove Factories	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Glue Factories	1	..	..	..	..	..	..	..	1	..	..	..	..	2
Groceries	3	..	1	..	1	..	..	..	..	..	..	..	..	5
Hat Factory	2	3	1	..	1	..	..	..	..	..	..	..	..	7
Hatters' Fur Mfg	2	..	..	..	..	..	1	..	..	..	..	..	..	3
Hotels	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Institutions	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Jewelry Shops	2	1	..	2	..	..	1	..	..	..	..	..	..	6
Junk Shops	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Knitting, Cop Yarn	..	1	3	..	..	..	..	1	..	1	..	..	..	6
Knitting, Full Process	7	9	5	1	1	..	1	..	..	1	..	..	..	25
Laundries	2	..	..	..	..	..	..	1	..	..	..	..	..	3
Lead Pencil Works	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Linseed Oil Works	..	..	..	..	..	..	..	..	..	2	..	..	..	2
Machine Shops	14	3	1	1	..	1	..	1	..	1	..	..	1	23
Match Factories	2	..	..	..	..	..	..	..	1	..	..	..	1	4
Mattress Factories	3	2	..	1	..	..	..	1	..	..	..	..	..	7
Mercantile	10	2	..	2	1	..	2	..	..	..	4	..	1	22
Metal Workers	16	13	2	..	..	1	3	3	4	2	2	1	3	50
Miscellaneous	7	5	3	1	1	2	2	1	4	2	2	..	1	31
Morocco Leather Shops	3	3	..	..	1	..	1	..	..	..	..	..	..	8
Motion Pictures	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Munitions Factories	2	..	..	1	..	..	..	..	4	1	..	..	1	9
Musical Instrument Factories	1	3	..	..	..	..	1	..	..	..	1	..	..	6
Oilcloth and Linoleum Works	..	4	..	..	..	..	1	3	11	..	..	..	..	19
Oil Refinery	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Packing House and Slaughter	1	2	1	..	2	..	..	..	..	..	..	..	1	7
Paint and Color Works	1	2	2	..	..	..	3	..	..	..	..	..	..	8
Paper Box and Papeterie	3	1	..	..	..	..	..	..	..	..	..	..	..	4
Paper Mills	11	19	6	3	..	2	2	..	3	1	2	1	9	59
Patent Leather Works	1	..	1	1	..	..	1	..	..	..	..	..	..	4
Phonograph Works	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Photograph Works	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Picture Frame Factories	1	2	1	1	..	..	..	1	..	..	..	..	..	6
Potteries	1	1	..	1	..	..	..	..	..	1	..	..	..	4
Printing and Lithographing	6	4	1	..	..	..	1	1	..	..	3	..	1	17
Pulp Mills	6	3	3	..	1	1	..	..	..	1	..	..	1	16
Restaurants	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Rolling, Wire and Tube Works	..	..	..	..	..	..	1	..	..	..	..	..	1	2
Roofing Works	2	2	..	1	..	..	..	..	..	1	..	..	..	6
Rubber Reclaiming Works	1	..	..	..	..	..	1	..	..	..	..	..	..	2

Table No. 9—Concluded.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to Distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged Heads.	Miscellaneous.	Total.
Rubber Works	6	..	..	1	..	..	..	1	5	3	..	..	1	17
Saw and Planing Mills	11	7	1	..	4	1	6	2	3	..	5	1	2	43
Shoddy Mills	6	2	6	..	1	3	..	1	..	..	..	..	1	20
Silk Mills	2	1	..	..	..	..	..	..	..	1	..	..	..	4
Soap Manufacturing	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Stamping and Sheet Metal Works	1	2	1	..	1	..	..	..	..	..	2	..	..	7
Starch and Glucose Mills	..	..	..	..	..	..	..	..	1	6	..	..	..	7
Sugar Refineries	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Tanneries	1	1	..	3	..	..	..	..	..	..	1	..	1	7
Tenant Manufacturing	22	7	2	2	1	..	2	1	1	..	6	..	2	46
Theatres	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Tobacco Factories	1	1	..	..	..	..	..	..	..	..	1	..	..	3
Trunk Factories	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Varnish Works	..	..	1	..	..	..	..	..	1	..	..	..	..	2
Wall Paper Factories	..	..	1	..	..	..	..	1	..	..	1	..	..	3
Warehouses	10	3	1	..	2	..	1	3	..	..	..	..	3	23
Waste and Batting Mills	3	4	3	1	..	1	..	1	1	..	..	..	1	15
Waste Paper and Rag Shops	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Weaving Mills	1	1	1	1	..	..	..	..	..	..	..	..	..	4
Window Shade Factories	..	..	..	1	..	..	..	..	1	..	..	..	..	2
Woodworkers, Class A*	10	9	1	..	..	1	..	5	..	3	3	1	3	36
Woodworkers, Class B*	6	8	2	1	..	2	1	1	..	3	2	..	2	28
Woodworkers, Class C*	3	4	1	..	..	..	..	2	..	..	..	..	..	10
Woodworkers, Class D*	1	7	..	1	1	..	..	..	..	2	4	..	3	19
Woodworkers, Class E*	3	2	..	..	2	1	2	..	..	..	1	..	..	11
Woodworkers, Class F*	2	..	1	..	..	..	..	1	..	..	..	..	..	4
Woolen Mills	14	16	12	1	..	2	4	..	1	..	3	..	8	61
Wool Storehouses	..	2	..	..	..	..	..	..	..	..	..	..	..	2
Worsted Mills	3	3	2	1	..	..	1	..	..	..	..	..	4	14
Total Unsatisfactory Fires	360	249	111	41	33	22	62	70	70	55	71	6	77	1227

*See detailed classification of woodworkers as given in note under Table No. 8.

Table 10.

Secondary Water Supplies to Sprinkler System.

Occupancy	Total No. of Fires	Secondary Supply: When a Factor	Secondary Supply: % Total	Primary Supply: Waterworks	Primary Supply: Gravity Tanks	Primary Supply: Pressure Tank	Primary Supply: Misc. Pumps†	Secondary Supply: Waterworks	Secondary Supply: Gravity Tank	Secondary Supply: Pressure Tank	Secondary Supply: Steam Pump	Secondary Supply: Misc. Pumps†	Secondary Supply: Steamer Connection
Agricultural Implements	90	3	3.3	3	..	..	..	..	..	..	2	1	..
Auto and Bicycle Fac. .	198	6	3.0	2	1	1	2	2	3	..	..	1	..
Bag Factories	23	2	8.7	..	..	2	..	..	2	..	..	..	..
Bakeries	95	1	1.1	1	..	..	..	..	1	..	..	..	..
Bolt, Nut and Screw Works	26	2	7.7	1	..	..	1	1	..	..	1	..	..
Boot and Shoe Shops ...	762	14	1.8	9	3	2	..	2	6	1	3	2	..
Broom Factories.....	17	1	5.9	1	..	..	..	..	1	..	..	..	..
Button Factories	51	1	2.0	..	..	1	..	..	1	..	..	..	..
Candle Factories	10	1	1.0	..	..	1	..	..	1	..	..	..	..
Candy Factories.....	155	5	3.2	1	..	4	..	3	1	..	..	..	1
Car House	60	1	1.7	1	..	..	..	..	1	..	..	..	..
Car Works	115	3	2.6	2	1	..	..	..	..	..	3	..	..
Carpet Mills.....	257	5	1.9	3	2	..	..	1	..	..	3	1	..
Carriage Factories.....	166	16	9.6	10	1	5	..	2	8	..	3	2	1
Celluloid Works.....	202	15	7.4	13	1	1	..	..	5	..	8	1	1
Cement and Plaster.....	6	2	33.3	..	1	1	..	..	1	..	..	1	..
Cereal Mills	49	4	8.2	2	..	2	..	..	..	1	1	2	..
Chemical and White Lead.....	157	16	10.2	2	12	1	1	..	2	..	9	3	2
Clothing	1133	24	2.1	1	..	23	..	2	18	1	1	2	..
Coffin Factories	65	2	3.1	..	1	1	..	..	1	..	1	..	..
Cooperage Plants.....	84	6	7.1	1	..	5	..	3	3	..	..	..	..
Cordage Works.....	319	34	10.6	12	6	14	2	11	5	..	12	4	2
Cork Factories	29	1	3.5	..	1	..	..	..	..	..	1	..	..
Cotton Mills.....	6338	388	6.1	69	311	7	1	4	9	..	267	108	..
Cotton Warehouses.....	313	23	7.4	6	17	..	..	1	3	..	15	4	..
Cotton Seed Oil Mills...	80	17	21.2	1	14	1	1	1	1	..	12	3	..
Department Stores	498	10	2.0	2	3	5	..	..	4	1	1	3	1
Distilleries	11	3	27.2	..	1	1	1	1	..	1	1	..	..
Drug Houses.....	210	10	4.8	5	..	5	..	..	7	..	1	..	2
Dyeing, Bleaching and Finishing	272	7	2.6	3	4	..	..	1	..	..	5	1	..
Electrical Appliances ...	214	4	1.9	3	..	1	..	..	..	..	3	1	..
Electric Light and Power	12	1	8.3	..	1	..	..	..	..	..	1	..	..
Elevators, Grain	69	17	24.6	2	5	8	2	2	1	..	8	6	..
Fertilizer Plants	37	7	18.9	1	2	3	1	1	2	..	3	1	..
Flour Mills	100	10	10.0	2	4	4	..	3	1	..	3	2	1
Foundries	257	5	1.9	3	2	..	..	1	1	..	3	..	..
Furniture Factories.....	775	51	6.6	23	9	18	1	11	16	..	16	5	3
Garages.....	208	4	1.9	..	1	3	..	1	3	..	..	..	..
Glass Works.....	95	6	6.3	3	1	2	..	..	3	..	1	2	..
Glove Factories	13	1	7.7	1	..	..	..	1	..	..	..	..	..
Glue Factories	12	3	25.0	..	3	..	..	..	..	..	3	..	..
Harness and Fancy Leather.....	113	5	4.4	..	..	5	..	..	5	..	..	..	..
Hat Factories	201	9	4.5	2	3	4	..	1	3	1	3	..	1
Hatters' Fur Mfg.....	23	1	4.4	1	..	..	..	..	1	..	..	..	..

Table 10—Continued.

Secondary Water Supplies to Sprinkler System.

Occupancy		Secondary Supply		Primary Supply				Secondary Supply					
	Total No. of Fires	When a Factor	% Total	Waterworks	Gravity Tank	Pressure Tank	Misc. Pumps†	Waterworks	Gravity Tank	Pressure Tank	Steam Pump	Misc. Pumps†	Steamer Connection
Inc. Lamp Factories....	24	1	4.2	..	1	..	..	1	..	..	..	..	..
Insulated Wire Factories	47	2	4.3	..	2	..	..	..	..	..	2	..	..
Junk Shops	23	2	8.7	1	..	1	..	..	2	..	..	..	..
Knitting Mills, Cop Yarn	65	2	3.1	..	2	..	..	..	..	..	1	1	..
Knitting Mills, F. P.....	742	27	3.6	6	20	1	..	1	1	..	12	13	..
Linseed Oil Works.....	30	6	20.0	..	2	3	1	..	..	1	1	4	..
Machine Shops	514	11	2.1	1	3	7	..	2	2	..	6	1	..
Match Factories	69	4	5.8	..	1	1	2	3	..	..	..	1	..
Mattress Factories.....	477	19	4.0	2	9	8	..	4	4	..	9	..	2
Mercantile	1069	35	3.3	5	1	27	2	13	11	1	..	3	7
Metal Workers	1235	39	3.2	17	11	8	3	5	8	1	21	3	1
Miscellaneous	627	34	5.4	16	7	8	3	2	14	1	12	5	..
Morocco Leather	61	3	4.9	3	..	..	..	..	..	..	2	1	..
Motion Picture	65	3	4.6	1	1	1	..	..	1	1	1	..	..
Munition Factories	51	9	17.7	..	9	..	..	..	..	..	9	..	..
Musical Instrument Factories	171	8	4.7	2	2	4	..	..	6	..	1	1	..
Office Buildings	26	2	7.8	1	1	..	..	1	1	..	..	..	..
Oil Clothing Factories ..	16	1	6.3	..	..	1	..	1	..	..	..	..	..
Oil Cloth and Linoleum.	107	38	35.6	9	26	..	3	4	4	..	23	7	..
Oil Refineries (Vegetable).....	7	2	28.6	..	1	1	..	1	..	..	1	..	..
Packing House	186	11	5.9	6	3	2	..	2	1	..	3	4	1
Paint and Color Works..	224	12	5.1	2	2	8	..	4	3	..	4	1	..
Paper Box	208	8	3.8	2	2	4	..	2	3	..	1	..	2
Paper Mills.....	729	65	8.9	22	37	1	5	3	2	..	45	15	..
Phonograph Works	24	1	4.2	..	..	1	..	..	1	..	..	..	..
Picture Frames.....	61	4	6.6	..	1	3	..	..	2	1	1	..	..
Plumber's Supplies	25	2	8.0	1	..	1	..	..	2	..	..	..	..
Potteries	69	3	4.3	..	1	..	2	..	2	..	1	..	..
Printing	718	9	1.2	2	3	4	..	2	5	..	1	..	1
Pulp Mills.....	85	12	14.1	7	3	1	1	1	..	..	10	1	..
Restaurants.....	51	1	2.0	..	..	1	..	..	1	..	..	..	..
Rolling, Wire and Tube Works.....	45	2	4.4	1	1	..	..	..	..	..	1	1	..
Roofing Works	63	9	14.2	4	5	..	..	..	3	..	5	..	1
Rubber Cloth Factories.	43	2	4.6	1	1	..	..	..	..	..	1	1	..
Rubber Reclaiming Works.....	17	3	17.7	1	2	..	..	..	..	..	3	..	..
Rubber Works	262	11	4.2	3	7	1	..	1	..	..	4	5	1
Saw and Planing Mills..	185	37	20.0	16	12	..	9	2	8	..	18	8	1
Schools	10	1	10.0	1	..	..	..	..	..	..	..	1	..
Shirt Factories	52	1	1.9	1	..	..	..	..	..	..	..	1	..
Shoddy Mills.....	292	15	5.1	10	3	1	1	..	3	..	9	3	..
Silk Mills.....	101	1	1.0	..	..	1	..	..	1	..	..	..	..
Skin Mills	3	1	33.3	1	..	..	..	..	..	..	..	1	..
Soap Manufacturing ...	43	2	4.6	1	1	..	..	1	..	1	..	..	..

Table 10 — Concluded.

Secondary Water Supplies to Sprinkler System.

Occupancy	Total No. of Fires	Secondary Supply: When a Factor	Secondary Supply: % Total	Primary Supply: Waterworks	Primary Supply: Gravity Tank	Primary Supply: Pressure Tank	Primary Supply: Misc. Pumps†	Secondary Supply: Waterworks	Secondary Supply: Gravity Tank	Secondary Supply: Pressure Tank	Secondary Supply: Steam Pump	Secondary Supply: Misc. Pumps†	Secondary Supply: Steamer Connection
Stamping and Sheet Metal Works	94	7	7.5	4	2	1	..	2	3	..	2	..	..
Tanneries	82	5	6.1	4	..	1	..	..	..	..	4	..	1
Tenant Manufacturing	861	14	1.6	1	2	9	2	1	8	2	3	..	..
Varnish Works	31	1	3.2	..	1	..	..	..	..	..	1	..	..
Wall Paper Factories	19	2	10.5	..	2	..	..	..	..	..	2	..	..
Warehouses	466	27	5.8	8	9	7	3	4	13	..	7	3	..
Waste and Batting Mills	400	15	3.7	7	3	5	..	3	3	..	3	3	3
Waste Paper and Rags	109	4	3.7	..	..	4	..	3	1	..	..	..	..
Weaving Mills	175	7	4.0	..	7	..	..	..	..	..	4	3	..
Woodworkers, Class A*	258	16	6.2	10	2	3	1	1	5	1	4	4	1
Woodworkers, Class B*	276	19	6.9	6	6	6	1	2	8	..	4	3	2
Woodworkers, Class C*	206	9	4.4	2	4	..	3	..	5	..	2	2	..
Woodworkers, Class D*	150	8	5.3	6	..	..	2	1	5	..	1	1	..
Woodworkers, Class E*	224	5	2.2	3	1	1	..	..	1	..	..	4	..
Woodworkers, Class F*	56	6	10.7	3	2	1	..	2	1	..	2	1	..
Woolen Mills	1272	74	5.8	25	40	3	6	2	10	..	30	32	..
Worsted Mills	107	2	1.9	1	1	..	..	..	..	..	2	..	..
Total	27,628	1429		418	676	272	63	133	274	16	673	294	39

*See detailed classification of woodworkers as given in note under Table No. 8.

†See footnote under Table No. 11.

Table No. 11—Secondary Water Supplies to Sprinkler System.

1922-1923.

Primary Supply	No. of Fires where Secondary Supply was a Factor	Secondary Supply: Waterworks	Secondary Supply: Gravity Tank	Secondary Supply: Pressure Tank	Secondary Supply: Steam Pump	Secondary Supply: Misc. Pump†	Secondary Supply: Steamer Connection
Water Works	52	1	20	1	21	9	..
Gravity Tank	43	2	2	..	36	3	..
Pressure Tank	30	6	20	..	2	1	1
Misc. Pumps†	7	2	3	1	1	..	..
Total	132	11	45	2	60	13	1

†Miscellaneous pumps include water supplies reported as automatic steam pump, automatic electric pump, automatic fire pump, fire pump, rotary pump and pump with no designation of type.

Section III.

Efficiency of Primary Water Supply.

These tables, first printed a year ago, show no important change during the past year. As can be seen from Table No. 2, the pressure tank extinguished 66.6 per cent of the fires with one or two heads and therefore shows a greater efficiency than the other primary supplies. This is probably due to the fact that pressure tanks are largely used in occupancies where numerous small fires may occur.

Table No. 1.

Effect of Sprinklers.

1922-1923.

	W. W.	%	G. T.	%	P. T.	%	Pumps	%	No Data	Totai	%
Ext. Fire	633	66.3	214	64.4	426	82.7	66	68.8	12	1351	70.2
Held fire in check	279	29.2	102	30.8	80	15.5	25	26.0	6	492	25.5
Failure	43	4.5	16	4.8	9	1.8	5	5.2	10	83	4.3
Total	955		332		515		96		28	1926	

1910-1923.

	W. W.	%	G. T.	%	P. T.	%	Pumps	%	No Data	Total	%
Ext. Fire	6436	64.0	2478	63.3	2812	80.3	677	69.8	96	12499	67.0
Held fire in check	3246	32.3	1312	33.5	648	18.5	263	27.0	54	5523	29.6
Failure	373	3.7	123	3.2	43	1.2	31	3.2	56	626	3.4
Total	10055		3913		3503		971		206	18648	

Table No. 2.

Number of Sprinklers Operating.

1922-1923.

No. of Sprinklers Operating	W.W.	%	G.T.	%	P.T.	%	Pumps	%	No Data	Total	%
1	329	34.8	91	28.0	233	45.4	34	36.1	6	693	36.4
2	177	18.8	39	12.0	109	21.2	17	18.1	4	346	18.5
3	88	9.3	35	10.7	56	10.9	5	5.3	2	186	9.8
4	68	7.2	29	8.9	30	5.8	5	5.3	1	133	7.0
5	38	4.0	21	6.5	19	3.7	4	4.2	2	84	4.4
6	31	3.3	12	3.8	17	3.3	1	1.1	1	62	3.3
7	27	2.9	11	3.4	9	1.7	4	4.2		51	2.7
8	21	2.2	8	2.5	8	1.5	3	3.2		40	2.1
9	14	1.5	5	1.5	5	1.0	1	1.1		25	1.3
10	17	1.8	2	.6	3	.6	1	1.1		23	1.2
11	11	1.2	6	1.8	6	1.1	1	1.1		24	1.3
12	8	.9	5	1.5	2	.4	1	1.1		16	.8
13	6	.6	7	2.1	2	.4	1	1.1		16	.8
14	5	.5	4	1.2	2	.4	1	1.1		12	.6
15	15	1.6	4	1.2	1	.2				20	1.1
16 to 20	21	2.2	9	2.8	5	1.0	3	3.2	1	39	2.1
21 to 25	13	1.4	5	1.5	1	.2	2	2.1		21	1.1
26 to 30	9	.9	9	2.8	1	.2	3	3.2		22	1.2
31 to 35	6	.6	4	1.2			2	2.1		12	.6
36 to 40	10	1.1	4	1.2	1	.2	2	2.1		17	.9
41 to 50	5	.5	4	1.2					1	10	.5
51 to 75	8	.9	6	1.8						14	.7
76 to 100	2	.2	3	.9	1	.2	1	1.1		7	.4
Over 100	15	1.6	3	.9	3	.6	2	2.1		23	1.2
No Data	11		6		1		2		10	30	
Total	955		332		515		96		28	1926	

Table No. 2—Continued.

Number of Sprinklers Operating.

1910-1923.

No. of Sprinklers Operating	W. W.	%	G. T.	%	P. T.	%	Pumps	%	No. Data	Total	%
1	3165	32.0	1112	28.8	1736	49.6	305	31.8	37	6355	34.5
2	1704	17.2	629	16.3	732	20.9	164	17.1	27	3256	17.6
3	934	9.4	373	9.6	329	9.4	85	8.8	16	1737	9.4
4	743	7.5	306	7.9	199	5.7	64	6.7	13	1325	7.2
5	453	4.6	180	4.7	105	3.0	40	4.2	9	787	4.3
6	374	3.8	177	4.6	70	2.0	33	3.4	9	663	3.6
7	273	2.7	113	2.9	49	1.4	30	3.1	7	472	2.6
8	266	2.7	104	2.7	31	.9	23	2.4	6	430	2.3
9	173	1.7	65	1.6	25	.7	19	2.0	3	285	1.6
10	167	1.7	57	1.4	23	.7	11	1.2	3	261	1.4
11	106	1.1	51	1.3	20	.6	10	1.0	2	189	1.0
12	146	1.5	71	1.8	16	.5	9	.9	5	247	1.4
13	83	.8	43	1.1	9	.2	11	1.2	2	148	.8
14	94	.9	35	.9	13	.4	8	.8	2	152	.8
15	77	.8	49	1.3	10	.3	8	.8	1	145	.8
16 to 20	275	2.8	110	2.8	27	.8	39	4.1	4	455	2.5
21 to 25	191	1.9	76	2.0	16	.5	22	2.3	8	313	1.7
26 to 30	121	1.2	57	1.5	14	.4	14	1.5	1	207	1.1
31 to 35	75	.8	43	1.1	8	.2	10	1.0	4	140	.8
36 to 40	76	.8	36	.9	9	.2	13	1.4	1	135	.7
41 to 50	96	1.0	42	1.1	14	.4	8	.8	5	165	.9
51 to 75	111	1.1	68	1.8	16	.5	11	1.2	4	210	1.2
76 to 100	61	.6	21	.5	5	.1	4	.4	4	95	.5
Over 100	139	1.4	53	1.4	21	.6	18	1.9	10	241	1.3
No Data	152		42		6		12		23	235	
Total	10055		3913		3503		971		206	18648	

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